Personalized Health Monitoring System to Track and Visualize Serum Creatinine Levels of Chronic Kidney Disease Patients: Creatinine Care

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Abstract* - Creatinine Care is a mobile application developed to monitor and manage serum creatinine levels in chronic kidney disease patients. Chronic kidney disease is a significant global health issue affecting both adults and children. Many patients are unaware of their kidney health status, leading to sudden spikes in creatinine levels and emergency hospitalizations. Serum creatinine is a critical biomarker used in estimating kidney function, particularly through the glomerular filtration rate formula. However, most existing kidney-related applications focus on general awareness, basic health tracking, and diet plans, without offering specific creatinine-level monitoring or paediatric support. This application addresses these gaps by offering a dedicated platform for both adult and child kidney patients to track creatinine levels over time. Key features include digital report storage, automated data extraction, visual trend analysis, checkup reminders, and personalized recommendations based on the base creatinine level. The system is developed using React Native with Expo Go for the frontend and SQLite for local storage. A Node.js Express backend supports Optical Character Recognition through Tesseract.js for extracting data from scanned reports. Evaluation involved user acceptance testing and text extraction accuracy testing. The Optical Character Recognition achieved a word-level accuracy of 93.33% on high-quality images and 76.92% on low-quality images, with an overall upload success rate above 86%. The results demonstrate the system's effectiveness in reducing manual data entry, improving patient awareness, and supporting real-time monitoring. Creatinine Care introduces a novel, all-in-one digital tool for personalized chronic kidney disease management in paediatric and adult patients.Keywords*— Chronic Kidney Disease, Creatinine Base Level, Glomerular Filtration Rate, Serum Creatinine Level, Health Matrix Calculations, OCR, Regex Pattern.**

I. Introduction

Chronic Kidney Disease (CKD) is a growing global health concern that affects individuals of all ages. As early diagnosis and ongoing monitoring play a critical role in managing CKD, the use of digital health tools has become increasingly relevant. This research focuses on developing a mobile application specifically designed to improve chronic kidney disease management by tracking serum creatinine levels, visualizing trends, providing personalized reminders, and supporting both paediatric and adult patients.

II. Background

CKD is a progressive condition in which kidney function deteriorates, leading to reduced blood filtration efficiency. Despite its prevalence, patient awareness regarding kidney health remains low. Tracking CKD in adults and children requires different approaches due to physiological and developmental differences.

Kidney health is commonly assessed using the glomerular filtration rate (eGFR) or the serum creatinine level in the blood. Serum creatinine, a metabolic waste product filtered by the kidneys, is a key indicator in estimating eGFR values [1]. Studies have shown that CKD during childhood can cause long-term complications that persist into adulthood [2]. Low health literacy among patients often results in delayed diagnosis, avoidable health emergencies, and unplanned hospitalizations [3]. The advancement of health information systems has shifted the management of medical records from paper-based formats to digital solutions, enabling individuals to store and access their health information more efficiently [4].

Despite the availability of general CKD-related applications, there is a lack of tools specifically focused on serum creatinine tracking. Additionally, most existing systems do not distinguish between adult and paediatric CKD management needs. To address this gap, this project introduces a mobile application that supports users in uploading creatinine reports, calculating base creatinine levels, receiving reminders for upcoming checkups, visualizing creatinine trends, and estimating eGFR values. The system is designed to provide a tailored experience for both adults and children, contributing to improved CKD monitoring and health outcomes.

III. Existing Systems

https://doi.org/10.54389/RCQA8713

CKD management is supported by various mobile applications designed to improve patient awareness and facilitate personal health tracking. These systems commonly focus on general health metrics, eGFR calculations, educational content, or supportive care.

The "Know Your Kidney" application enables users to manually input health data, set reminders, and follow diet plans. However, it lacks automated analysis features such as kidney function estimations and health metric visualizations. Its reliance on manual data entry also increases the potential for human error [5].

The "SUCCESS" application focuses on delivering multimedia-based health education for CKD patients but does not include features for health data analytics, digital report storage, or creatinine-based tracking. Its primary objective is to raise general awareness rather than support interactive disease management [6].

Similarly, the "MiKidney" application emphasizes patient self-care and provides educational content aimed at reducing hospitalizations. While it offers reminders and patient feedback, it does not support core medical data analysis functionalities such as creatinine level tracking or clinical metric calculations [7].

The eGFR Calculator is designed to estimate glomerular filtration rate using standard clinical formulas. Although it aids in evaluating kidney function, it does not support long-term creatinine monitoring or medical report integration, limiting its usefulness in comprehensive CKD management [8].

A. Research Gap

While these existing systems offer fragmented solutions for kidney care, there remains a critical gap in applications that centralize creatinine monitoring as a core feature. Most existing applications are designed for adults and primarily rely on eGFR estimations without emphasizing the underlying creatinine values. Furthermore, there is a lack of specialized tools for managing CKD in paediatric patients, despite the significant differences in clinical guidelines between children and adults. The proposed Creatinine Care application addresses this gap by providing a comprehensive, integrated solution specifically tailored for monitoring CKD in children. It focuses on creatinine level tracking while also incorporating features such as eGFR calculation, personalized health recommendations, automated reminders, report visualization, and age-specific analysis. This holistic approach to creatinine-centred care represents a novel contribution in the landscape of CKD management tools. Table I provides a feature-based comparison of existing CKD-related mobile applications. It highlights that Creatinine Care uniquely integrates all key functionalities such as report uploading, creatinine tracking, eGFR calculation, and child-specific CKD support, setting it apart as a comprehensive solution.

TABLE IX
COMPARISON ANALYSES OF EXISTING SYSTEMS

Feature	Know Your Kidney App	MiKidney App	eGFR Calculator	Creatinine Care
Upload scanned reports				✓
Manually adding test results	✓	✓		
Calculating creatinine level / eGFR	eGFR only		eGFR only	Creatinine level and eGFR
Visual Trend analysis				✓
Reminders	✓	✓	✓	✓
Tailored Suggestions		✓		✓
Educational content	✓	✓	✓	✓
Child CKD Support				✓

IV. AIM AND OBJECTIVES

A. Purpose of the Study - Aim

The Creatinine Care mobile application aimed to develop a personalized kidney health monitoring system to track, visualize, manage, and remind the serum creatinine levels of children with chronic kidney disease.

B. Research Objectives

- To identify similar systems and reachable solutions.
- To develop optical character recognition (OCR) functionality for extracting test report data.
- To calculate the creatinine base level and provide tailored recommendations.
- To integrate a reminder system for regular and timely checkups.
- To develop a visual trend component to track and visualize data flow over time.
- To implement the proposed system.
- To test and evaluate the system with the target audience.

V. SCOPE

The Creatinine Care application is designed as a dedicated tool to monitor serum creatinine levels in CKD patients by offering personalized health tracking that visualizes creatinine trends over time, along with timely checkup reminders and tailored recommendations. The application does not currently support the calculation or tracking of other health metrics, nor does it offer multi-language support. Additionally, it does not include features for diet planning or medication tracking. The key features of the system are as follows:

- User Login and Register

- Scan test reports and extract creatinine levels.
- Creatinine level trends visualization over time.
- Notifications for upcoming checkups.
- Calculate base creatinine level and provide tailored recommendations.
- Calculate eGFR rate and provide recommendations.
- Profile management.
- Report history management.
- Educate users by incorporating medical information.

VI. Research Contribution

- Developed a mobile application specifically targeting creatinine tracking in real time, a gap in current CKD solutions.
- Designed a child-inclusive CKD management system, addressing the lack of paediatric-specific tools.
- Introduced automated OCR-based report extraction, reducing manual entry effort.
- Enabled trend analysis and base creatinine level calculation for long-term health insight.
- Contribute to digital health applications by being a part of mobile health management and creating a user-friendly application.

VII. Methodology

The Creatinine Care application was developed using the agile methodology, with the scrum framework guiding the development process. This iterative and incremental approach facilitated sprint-based planning, regular testing, and continuous incorporation of user feedback. The project was divided into five sprints, each lasting two weeks and focusing on specific functional goals. Functionality and usability testing were conducted at the end of each sprint. Sprint progress was tracked using a Gantt chart, ensuring the timely delivery of features and effective scope management.

The system architecture consists of three core components: the frontend, the backend, and the local database (Figure 1). The frontend was built using React Native and Expo Go, handling user interactions and core features such as onboarding, profile management, image upload, notifications, eGFR calculation, trend visualization, and report history. The backend was developed using Node.js and Express, responsible for processing uploaded medical reports. Upon receiving an image, the backend uses Tesseract.js OCR to extract serum creatinine values and test dates and returns the data to the frontend via a RESTful API. All extracted and user-entered data are stored in a local SQLite database, which includes tables for users and medical reports. Supporting tools and libraries used during development include:

- Image upload: expo-image-picker
- Notifications: Expo Notifications
- Charts: react-native-chart-kit (Line Chart)
- Version control: GitHub

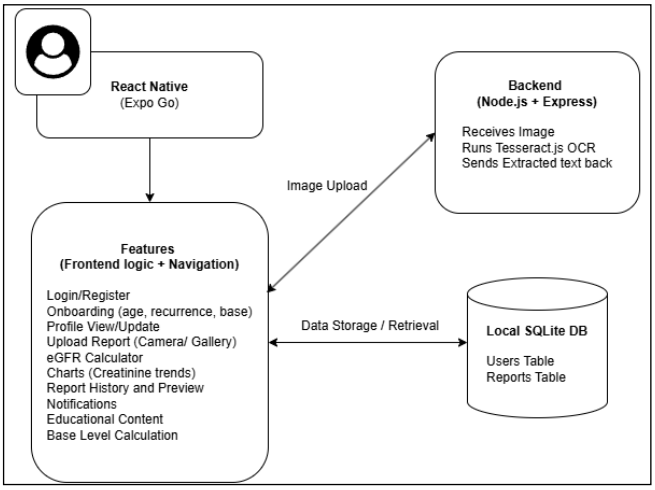

Fig. 9. System Architecture of the Creatinine Care Application

Fig. 1. demonstrates how the React Native frontend communicates with the backend server to extract data from scanned medical reports, and how all relevant data is stored and retrieved from the local SQLite database.

VIII. Evaluation and Testing Results

The Creatinine Care application was evaluated through multiple methods to assess functionality, accuracy, and performance. User feedback was gathered at the end of each sprint under the agile scrum framework. Based on this feedback, several improvements were made, including user interface enhancements and the addition of the eGFR calculator as a key new feature. Test cases were developed for each user story, and systematic debugging and notification reliability testing were conducted to ensure system robustness.

The OCR text extraction accuracy was evaluated using real creatinine reports. Multiple metrics were employed, including word-level accuracy for reported dates, character-level accuracy for extracted creatinine values, and the Levenshtein distance between extracted and ground truth values.

TABLE X
OCR Accuracy and Benchmark Test Results

	Dataset 1 (Good Image Quality)	**Dataset 2 (Poor Image Quality)**
Word-Level Accuracy (Date)	93.33%	76.92%
Character-Level Accuracy (Creatinine)	86.67%	87.17%
Levenshtein Distance (Creatinine)	1.2	0.76
Overall Upload Success Rate	86.67%	80.23%

Average image processing time	3.90 seconds	3.99 seconds
Average memory usage	7,850 KB	5,330 KB

Table II presents the OCR accuracy and benchmark test results, highlighting the system's performance under two conditions: high-quality and low-quality report images. The table shows that OCR accuracy is notably influenced by image quality. Word-level accuracy for date extraction reached 93.33% with good image quality but dropped to 76.92% with poor quality. Character-level accuracy for creatinine values remained relatively stable across both datasets, while Levenshtein distance values reflected variations in extraction precision. The overall report upload success rate was 86.67% for high-quality images and 80.23% for low-quality ones. Average image processing time remained under 4 seconds, and memory usage varied slightly between the datasets.

IX. Social and Technical Challenges

A. User Adoption and Psychological Impact on Users.

One of the key challenges identified through user interviews was the issue of user adoption, particularly the psychological impact on parents of paediatric patients. Many parents lack a clear understanding of creatinine tracking and its importance, which may result in hesitation to use a digital health tool. Additionally, some users may struggle with technology or misinterpret trends and recommendations, potentially leading to confusion or unnecessary anxiety regarding the child's health. To mitigate these concerns, Creatinine Care incorporates intuitive user interfaces and clear in-app guidance to enhance usability and understanding.

B. OCR Accuracy and Reliability.

Users may upload test reports that are unclear or of low quality due to poor lighting conditions or limitations in device camera performance. Such issues can negatively impact the accuracy of OCR-based data extraction. Furthermore, there is a risk of users uploading duplicate or irrelevant reports, which may result in incorrect readings or inappropriate recommendations. To address these challenges, the system employs robust error-handling mechanisms designed to detect and manage inconsistencies and unsupported inputs effectively.

C. Security Concerns

Due to limitations in Expo's support for secure native modules, the application currently offers only basic user authentication through login and registration. Advanced security features such as encrypted storage or multi-factor authentication are not yet implemented and represent areas for future enhancement to ensure stronger data protection and user privacy.

X. Limitations

- OCR Accuracy – While the OCR text extraction accuracy is generally high, it is affected by image quality, lighting conditions, and device performance.
- Format Dependency – The OCR regex patterns currently support only two common lab report formats; unsupported formats may result in errors.
- Platform Support Limitations – The application was developed and tested using React Native with Expo, limiting compatibility outside that environment.
- Health Metrics Monitoring – The app focuses solely on creatinine tracking and does not support other reports such as urine or blood tests.

XI. Conclusion and Future Work

The Creatinine Care mobile application offers an innovative digital solution aimed at addressing common challenges faced by individuals managing chronic kidney conditions. The application simplifies the process of health tracking by enabling patients to record, monitor, and analyze serum creatinine levels over time. Key features such as automated data extraction from uploaded reports, personalized reminders based on test frequency, and graphical trend visualization assist both patients and healthcare providers in maintaining effective kidney care. Additionally, efficient report history management reduces the reliance on physical records, while the eGFR calculator further supports clinical understanding.

Looking ahead, several areas have been identified for future enhancement of the system. Improving OCR accuracy through the integration of advanced AI-based libraries can enhance the recognition of indistinct text in reports. Incorporating intelligent field detection mechanisms would also enable the application to support diverse report formats. Furthermore, the integration of cloud storage would allow for seamless backup and synchronization of user data across multiple devices, along with improved recovery options. To strengthen data privacy and user authentication, features such as biometric or two-factor authentication could be introduced. The system can also be extended to analyze additional health reports related to kidney function, offering a more comprehensive personal health management experience. Lastly, implementing multi-language support such as Sinhala, Tamil, and English would increase accessibility and usability for a broader range of users.

Acknowledgment

Appreciation is extended to those who provided academic guidance, constructive feedback, and domain-specific insights during the development of this research. Foundational knowledge, expert input, and practical perspectives significantly contributed to the refinement and applicability of the proposed solution. Acknowledgment is also given to the technical resources, including large language models, which assisted in resolving development-related challenges.

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