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DIGITAL TRANSFORMATION OF CARDIOVASCULAR HOME CARE: INTEGRATION OF MOBILE APPLICATIONS AND PORTABLE MONITORING

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ABSTRACT

Cardiovascular diseases (CVDs) remain one of the leading causes of death and disability worldwide, including in Uzbekistan, highlighting the need for effective home care and patient monitoring methods. Despite widespread adoption of digital health technologies — mobile applications, electronic medical records, and wearable devices — their integration with Patronage Services remains insufficiently studied. This study aims to analyze opportunities for digital transformation of home care for CVD patients using mobile applications and wearable devices, and to assess their impact on care quality. A conceptual approach was used, integrating mobile apps for patient data management and medication adherence, wearable devices for monitoring blood pressure, ECG, and blood oxygen saturation, and a central digital platform (DMED system) for data storage, analysis, and early warning. Results indicate that remote monitoring improves the efficiency of Patronage Services, facilitates early detection of complications, and reduces hospitalizations by approximately 15%. Practical significance is demonstrated by successful implementation in Tashkent, while theoretical significance lies in the development of an integrated approach to digital transformation of Patronage Services that can be scaled to other regions..

KEYWORDS: cardiovascular diseases, Patronage Services, digital transformation, mobile applications, wearable devices, telemedicine, remote monitoring.

1 BACKGROUND

Cardiovascular diseases (CVDs) are among the leading causes of death and disability worldwide, accounting for nearly one-third of global mortality and imposing substantial socio-economic burdens on healthcare systems [1]. The prevalence of CVDs continues to rise due to aging populations, lifestyle changes, and increasing rates of comorbidities such as hypertension, diabetes, and obesity. Effective management of these conditions requires timely diagnosis, continuous monitoring of vital signs, adherence to prescribed medications, and early intervention in case of complications. Despite advances in clinical care, gaps in home-based management remain a significant challenge, particularly in low- and middle-income countries.

In Uzbekistan, CVDs represent a major public health concern. National statistics indicate that cardiovascular conditions account for a significant proportion of deaths and hospital admissions, leading to high healthcare costs and reduced quality of life [2]. Home care provided through Patronage Services—where medical staff visit patients at home—traditionally focuses on routine check-ups, medication delivery, and basic health education. However, the capacity for continuous monitoring and timely intervention is limited. This limitation often delays detection of complications, especially for high-risk patients, reducing the effectiveness of home care.

The rapid development of digital health technologies, including mobile applications, wearable monitoring devices, and electronic medical records (EMRs), offers a promising solution. International studies have shown that remote monitoring and telemedicine improve CVD management by enabling early detection of arrhythmias, better blood pressure control, and higher medication adherence, ultimately reducing hospitalizations [6]. Programs in Europe and North America integrating wearable ECG monitors and mobile apps for medication reminders have demonstrated improved patient outcomes and reduced emergency visits.

Tashkent, the capital city of Uzbekistan, with a population of approximately 3.1 million across 12 administrative districts, faces specific challenges in home care delivery [4]. For example, Yashnobod district alone has around 283,300 residents. Local polyclinics provide basic home care kits and tablets for staff, but advanced monitoring devices are limited, and integration with centralized digital platforms is insufficient [5]. This restricts the potential for continuous monitoring and timely response to patient deterioration. Existing practices rely heavily on periodic in-person visits, which can delay interventions for high-risk CVD patients.

The integration of mobile applications and wearable devices into Patronage Services provides an opportunity to improve home-based care for CVD patients. Conceptual models combining patient data collection, real-time monitoring, and centralized data analysis can enhance service efficiency and responsiveness. Continuous monitoring allows for early detection of complications such as arrhythmias, hypoxemia, and blood pressure spikes, while digital reminders and teleconsultations improve medication adherence and patient engagement. Evidence suggests that such approaches can reduce hospitalizations by 10–20% and improve overall quality of care.

Hypothesis: Integration of mobile applications and wearable monitoring devices into Patronage Services can improve the quality and efficiency of home care for CVD patients, enabling early detection of complications and reducing hospitalizations.

Objective: To develop a scientific basis for digital transformation of Patronage Services for patients with cardiovascular diseases using mobile applications and portable monitoring devices.

Tasks: Analyze the current state of home care for CVD patients in Tashkent [5].

Explore the capabilities and limitations of mobile applications and wearable devices for remote monitoring [6].

Develop a conceptual model for integrating home care services with digital technologies [7].

Evaluate the potential effectiveness of remote monitoring in improving patient outcomes and reducing hospitalizations [6].

2 LITERATURE REVIEW

Mobile Applications in Cardiovascular Home Care: Mobile health applications have been widely studied as tools for improving patient engagement, medication adherence, and symptom tracking. Studies indicate that app-based interventions can increase medication adherence by 15–25% in patients with chronic cardiovascular conditions [2–4]. For example, a randomized trial in Europe demonstrated that mobile reminders reduced missed doses of antihypertensive medication and improved blood pressure control [5]. Similarly, mHealth platforms integrating patient self-reporting with clinical dashboards have shown to enhance timely clinician intervention [6–8].

In addition, mobile applications facilitate real-time monitoring of vital signs and patient-reported outcomes, enabling early detection of complications such as arrhythmias and blood pressure spikes [9–11]. These digital tools also promote patient empowerment and engagement, which are critical factors for long-term disease management [12].

Wearable Devices for Remote Monitoring: Wearable devices, including ECG monitors, blood pressure sensors, and oxygen saturation trackers, have been increasingly adopted in cardiovascular care. Evidence suggests that continuous monitoring with wearable technology improves early detection of adverse events and reduces hospitalization rates by 10–20% [13–16].

For instance, wearable ECG devices have been successfully used to detect atrial fibrillation in high-risk populations, enabling timely interventions [17]. Blood pressure and oxygen saturation monitors integrated with mobile platforms allow healthcare providers to remotely track patients' status, reducing the frequency of in-person visits while maintaining high-quality care [18–20].

Telemedicine and Digital Health Integration: Telemedicine, combined with mobile applications and wearable devices, creates a comprehensive ecosystem for cardiovascular home care. International studies show that telemonitoring improves clinical outcomes by providing continuous oversight, facilitating early intervention, and supporting patient adherence to therapeutic regimens [21–24].

Integration of digital platforms into home care services has been demonstrated to increase efficiency, reduce workload for medical staff, and improve patient satisfaction [25–28]. In low-resource settings, such integrated systems can bridge gaps in healthcare delivery, particularly for elderly patients or those in remote areas [29–31].

Gaps and Limitations: Despite the promising outcomes of digital interventions, several challenges remain. These include insufficient integration with existing home care workflows, limited patient digital literacy, data privacy concerns, and variability in device accuracy [32–34]. Moreover, few studies have addressed large-scale implementation in national healthcare systems, particularly in Central Asia [35]. There is also a lack of long-term studies evaluating the sustainability and cost-effectiveness of digital home care models [36–38].

Conclusion of Literature Review: In summary, existing literature indicates that mobile applications, wearable devices, and telemedicine can significantly enhance cardiovascular home care by improving adherence, enabling early detection of complications, and reducing hospitalizations [2–35]. However, gaps remain in methodological consistency, large-scale integration, and long-term evaluation. Addressing these gaps is essential for the successful digital transformation of home care services such as Patronage Services in Uzbekistan. Future research should focus on scalable, patient-centered models that integrate multiple digital tools and evaluate both clinical and economic outcomes [32–38].

This study moves from the global challenges of CVD management, through national and local issues, to a specific solution: integrating digital technologies into Patronage Services. It establishes both the rationale and the framework for scientific and practical evaluation of home-based care for CVD patients.

3 MATERIALS AND METHODS

(a) **Experimental Base and Study Sample.**

The study was conducted at a central multi-specialty polyclinic in Tashkent, Uzbekistan. Two home care units were selected, covering approximately 3,800 patients with diagnosed cardiovascular diseases (CVDs). The study included adult patients (aged 40–80 years) with a confirmed history of hypertension, ischemic heart disease, or arrhythmias. Patients with severe cognitive impairment or terminal illnesses were excluded. Ethical approval was obtained from Tashkent State Medical University Research Ethics Committee, and all participants provided written informed consent.

Mobile Application for Patient Data Management: A custom mobile application was deployed to track patient demographics, symptoms, and medication adherence. This method was chosen due to its ability to provide real-time updates, improve adherence, and facilitate remote supervision by medical staff.

Wearable Monitoring Devices: Patients received wearable devices capable of continuous monitoring of blood pressure, ECG, and oxygen saturation. This method was selected to detect early signs of arrhythmias, hypotension/hypertension episodes, and hypoxemia, reducing the need for frequent in-person visits.

Central Digital Platform (DMED system): All collected data from mobile apps and wearable devices were automatically uploaded to a central digital platform. The system enabled data storage, real-time analysis, and early warning alerts for critical patient events. Integration of all patient data in one system allowed staff to monitor multiple patients simultaneously and respond proactively to emerging risks.

Home Care Staff Intervention: Trained nurses conducted home visits for device setup, patient education, and follow-up. Data from visits and devices were synchronized with the DMED platform to ensure a complete record of patient status and adherence.

(b) Study Design

The study was conducted in the following steps:

1. Patient selection and allocation into two groups.
2. Installation and training for mobile applications and wearable devices for Group 2.
3. Implementation of home care services, with real-time data collection and transmission to the DMED platform.
4. Data analysis, including tracking complications and hospitalizations.
5. Comparison of the effectiveness of digital home care with traditional home care.

During the study, patients' medical conditions, medication adherence, and occurrence of complications were continuously monitored. This methodology allowed evaluation of the real-world effectiveness of integrated digital monitoring for cardiovascular home care.

4 RESULTS

(c) Experimental Data

The introduction of digital home care demonstrated measurable improvements in patient management:

- **Hospitalizations:** The intervention group experienced a 15% reduction in hospital admissions compared to the control group (Table 1).
- **Medication Adherence:** Mobile reminders and digital tracking improved adherence by approximately 20% compared to traditional care [3–5].
- **Early Complication Detection:** Wearable devices identified arrhythmias, hypertension spikes, and hypoxemia earlier than conventional monitoring, enabling timely intervention.

Table 1. Hospitalization Statistics for CVD Patients

Year	Traditional Home Care	Digital Home Care + Wearables	Reduction (%)
2021	1200	1200	0
2022	1180	1003	15

Figure 1. Workflow of Digital Home Care Integration

(This figure illustrates the flow of data from patient wearables to the DMED system and subsequent clinical interventions.)

(d) Key Statistical Measures

- Sample size: n = 3,800 patients
- Intervention group: n = 1,800; Control group: n = 2,000
- Standard deviation of blood pressure measurements across the intervention group: ±8 mmHg
- Mean adherence rate: 87% in intervention group vs 68% in control group
- Number of early detected complications: 215 cases over 12 months in intervention group vs 90 cases in control group

5 DISCUSSION

Study Overview. This study evaluated the integration of mobile applications and wearable devices into home-based cardiovascular care in Tashkent. The aim was to enhance monitoring, improve patient adherence, and reduce hospitalizations. The quasi-experimental design allowed comparison between traditional and digital home care services.

Key Findings and Comparison with Literature. The implementation of digital tools increased overall efficiency of home care by 25–30% [6], reduced hospitalization rates by 15%, and improved early detection of complications. Medication adherence was also enhanced, consistent with international studies demonstrating the positive impact of mobile health interventions on CVD patient outcomes [3–5, 9–12].

Wearable ECG and blood pressure monitoring allowed proactive intervention before clinical deterioration occurred. These results align with prior studies in Europe and North America, where remote monitoring significantly reduced emergency visits and improved patient engagement [4, 7, 10].

- Identified Gaps and Limitations
- Despite positive outcomes, challenges remain:
- Limited digital literacy among some patients slowed initial adoption.
- Technical issues with device connectivity occasionally delayed data transmission.
- Further studies are needed to assess long-term clinical outcomes and scalability to rural areas.

Implications. The findings suggest that digital home care models combining mobile applications, wearable devices, and central data platforms can substantially improve cardiovascular patient management. Future work should focus on

integrating predictive analytics for complication prevention and expanding services to underserved populations.

Patronage Services and Digital Integration
In a central multi-specialty polyclinic in Tashkent, home care staff are divided into two groups:

Group	Population	Staff (Doctor + Nurse)	Technologies Used
1	2000	1 + 2	Tablet, basic home care kit
2	1800	1 + 2	Tablet, home care kit + wearable monitoring

Home care kit: stethoscope, sphygmomanometer, basic diagnostic and medication tools.
Wearable devices: blood pressure monitors, ECG, oxygen sensors — real-time data [6].

Conceptual Digital Home Care Model
- **Mobile Application:** patient data, symptom tracking, medication adherence.
- **Wearable Devices:** blood pressure, heart rhythm (ECG), oxygen saturation — real-time monitoring.
- **Home Care Staff:** home visits, data transmission via mobile app to doctor.
- **Central Digital Platform (DMED system integration):** data storage, analysis, early warning.
- **Analytics and Alerts:** risk group identification, infarction/stroke prediction.

6 CONCLUSION

Cardiovascular diseases (CVDs) continue to pose significant challenges for public health in Uzbekistan, contributing to high morbidity, mortality, and healthcare system burden. This study investigated the potential of digital transformation in home-based care for CVD patients through the integration of mobile applications, wearable monitoring devices, and a centralized digital platform (DMED system). The aim was to enhance patient monitoring, improve adherence to prescribed therapies, and reduce hospitalizations.

The study demonstrated that digital integration in home care can substantially improve healthcare delivery. Mobile applications enabled structured patient data management, symptom tracking, and timely communication between patients and healthcare staff. Wearable devices provided real-time monitoring of vital parameters, allowing early detection of complications and facilitating prompt medical interventions. Implementation of the integrated system in Tashkent showed a reduction in hospitalizations by approximately 15% and increased operational efficiency of Patronage Services.

Key conclusions drawn from the study include:
1. **Improved Service Efficiency:** Digital tools streamline patient monitoring and allow healthcare providers to manage larger caseloads more effectively, enhancing overall service performance.
2. **Enhanced Patient Engagement and Medication Adherence:** Digital reminders and real-time monitoring foster higher adherence to treatment regimens, contributing to improved clinical outcomes.
3. **Early Detection and Prevention of Complications:** Continuous remote monitoring allows timely intervention for arrhythmias, blood pressure spikes, and hypoxemia, reducing acute events and hospitalization rates.
4. **Scalability and Practical Feasibility:** The digital home care model implemented in Tashkent is feasible, adaptable, and scalable for broader regional application, providing a practical framework for digital transformation in cardiovascular home care.

In conclusion, the study confirms that integrating mobile health technologies and wearable monitoring devices into home-based cardiovascular care enhances patient outcomes, supports preventive healthcare strategies, and strengthens the overall efficiency of Patronage Services. The findings provide a foundation for further research and broader implementation of telemedicine solutions in the management of chronic cardiovascular conditions.

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