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Review Article

Revolutionizing Cardiac Care: A Systematic Review Of Intelligent Wearables And Cloud-Based Analytics

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Abstract: *Cardiovascular diseases (CVDs) continue to be the number one cause of global mortality and thus need innovative and scalable monitoring solutions. Smart wearable devices and cloud-based analytics have recently allowed remote, real-time cardiac monitoring that increases diagnosis lead times and decreases treatment cycle times.* ***Objective:*** *In this systematic review, we aimed to summarize the clinical effectiveness, technological strengths and weaknesses of intelligent wearables and cloud-integrated systems in cardiac care.* ***Methods:*** *With the use of PRISMA 2020 guidelines, we searched PubMed, Google Scholar and IEEE Xplore for articles with titles and abstracts between 2017 and 2025. We identified data for types of devices, measured parameters, clinical outcomes and integration with analytics platforms from the structured abstracts and their elements.* ***Results:*** *The analysis of 21 studies has been presented. ECG patches, smartwatches and biosensor textiles had very high sensitivity to detect arrhythmias, heart failure signs and ECG modifications, respectively, for the detection of wearables. Researchers were able to conduct real-time analytics, predictive modeling with AI and link to electronic health records using the cloud-based platform. Clinical outcomes included HAP decreases hospitalization rates and improved treatment adherence early intervention. But hurdles like data privacy, interoperability and patient engagement still loom.* ***Conclusion:*** *Intelligent wearables with Cloud based analytics will revolutionize cardiac care and allow for remote monitoring using continuous data-driven decision making. However, the standardization and long-term effects must be tested before wide-scale clinical implementation is possible.*

Keywords: Cardiac care, wearables, cloud analytics, remote monitoring, artificial intelligence, systemic review

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Introduction

Cardiovascular diseases (CVDs) are still the number one killer in the world, leading to an estimated 17.9 million deaths/year of ~32% global mortality (1). The older the population, and with the complications of aging e.g. increasing obesity / sedentary behaviors associated with lifestyle, the expected increase in future prevalence CVDs. While early detection and continual surveillance are crucial to minimizing complications, these traditional tools — requiring in-clinic visits and serial tests — often fail to detect asymptomatic events such as paroxysmal atrial fibrillation. Intelligent wearable devices are such a transformative solution for filling this gap. The passively worn, real-time read cardiac monitoring in an ambulatory setting can be done by tele-medical devices (wearables) being currently available in the market such as smartwatches, ECG patches and even textile-based sensors. Numerous works suggest that wearable based systems can accurately detect arrhythmias, quantify heart rate variability (HRV) and induce predictive signs for heart failure (2-4). As an example, Poh et al.,(5) were selecting data from deep learning powered wrist-worn devices for atrial fibrillation detection holds high specificity and is a potential screening tool. Wearables along with cloud-based platforms, directly live data via remote patient monitoring for instant analytics and care delivery. The application of predictive models to streaming ECG data, have been shown to identify adverse cardiac events and suggest timely interventions. Such features represent a new age of cardiac care that is highly personalized and data-driven clinical decisions in near real time(6, 7). Damery et al. (8), said that for HC programs combining such technologies in a hybrid model significantly decrease hospital readmissions and enhance patient outcome. Emerging evidence from — for example Shiwlani et al. (9), and Kumar et al. (10) supports the role of deep learning models, sensor fusion & edge-cloud integration in improving Diagnostic accuracy and decreasing delay. A researcher presented a multi-channel deep neural network for arrhythmia classification to get more than 98% accuracy is real-world tests. Also scientists showed that a cloud-supported model can discover arrhythmias in less than 3 s combining ECG and PPG signals, much faster than conventional clinical assessments. This same market force is in evidence for wearables monitoring heart. The 2023 Price point was USD 3.72 Billion with an estimated value to USD 25.71 Billion by 2032 forecast. Such a boom is powered by advancing healthcare digitization, large burden of chronic diseases and post-COVID-19 expectation on remote care options. Although these advances have been made, the adoption of wearable-cloud ecosystems in routine care are not without hurdles. Legal compromises remained regarding data protection, standardization, device interoperability and patient adherence, especially in aged or digitally disadvantaged population (11, 12). Overcoming these barriers is a key component for achieving equitable access and attainable permanence. The purpose of this systematic review is to examine current literature on intelligent smartwatches and cloud-based analytics in cardiac care. We analyse their utility in clinical practice, health-system integration and potentially reshape the future of cardiothoracic care by synthesizing the evidence from comparative efficacy studies of recent and next generation technologies.

Methods

The Preferred Reporting items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 Statement was followed in the conduct of this systematic review (10).

Search Strategy

Articles published in the years (2017–2025) were identified via PubMed, google scholar and IEEE Xplore for a summative literature search. The search strategy was a combination of MeSHs/words.

Wearable devices" OR "smartwatch" OR "ECG patch" AND "cardiac monitoring" OR "heart disease" AND "cloud analytics" OR remote health monitoring" OR "artificial intelligence" OR "machine learning."

To widen the search results Boolean operators and truncations were used Reference lists of related articles were additionally screened through manual.

Eligibility Criteria

Studies were selected based on the following criteria, here in

Selection Process

Two independent reviewers screened all titles and abstracts in parallel. Full texts of studies that met the inclusion criteria or where eligibility was unsure were obtained. Differences were resolved through discussion or a third-party adjudication. A PRISMA 2020 flow diagram (Figure 1) illustrated the study selection process.

Data Extraction and Synthesis

Two independent reviewers extracted data from each study using a prespecified standardized form which has been piloted for clarity. Abstract data (study design, study populations, device type, cardiac parameters monitored, cloud service features and outcomes of interest) was critical. Discrepancies were resolved after discussion or referring it to third reviewer. This is because it was not possible to draw on a single meta-analysis (due to the heterogeneity in methodologies, e.g. different devices, monitoring durations, analytic tools and outcomes) across studies. Themes of studies were collapsed thematically as Type of wearable device, The Level of Cloud/AI integration, Clinical context, Outcome domain.This method enabled the qualitative comparisons, and emerging topics, innovations and literature gaps.

Results.

Study Selection

The beginning search identified 412 articles. After eliminating duplicates and applying the inclusion/exclusion criteria, 58 studies were selected for full-text review. Ultimately, there were 21 peer reviewed studies that were included in this review.

Types of Wearables and Monitoring Capabilities

This review examined a variety of cardiac monitoring wearable technologies that have been developed based on popular day-to-day uses for everyday health or clinical-grade diagnostics (e.g., wrist wearables to ambulatory ECGs etc). Device types of the common devices were wrist smartwatches, adhesive ECG patch (surgical tape), fabric-based sensors and implanted loop recorder. Wrist devices (e.g., Apple Watch and Fitbit) for convenience and a user-friendly method and adhesive patches such as Zio XT Patch received extended duration clinical grade ECG (3, 4).

The measurements traditionally monitored cardiovascular attributes, measuring ECGs hand behavior (HR), physical activity level/and may be monitored within wrist-worn devices with popular heart rate monitors (HRM) or devices like pulse oximeters marked for monitoring blood oxygen saturation (Blood Oxygen Saturation). Importantly, several non-implantable devices were able attain high specificity for the detection of atrial fibrillation (AF) and other arrhythmias (90% or greater) (2, 13). Advanced systems added multicenter ECGs for a refinement in diagnosis beyond consumer-grade applications (14).

Meanwhile smart textiles and non-contact systems received attention for comfort and suitable for long term monitoring in top-circulated situations, especially the most vulnerable patient populations like infants or elderly (15, 16). This pioneering work reduced system discomfort, improved comfort and comfort compared to devices of rigid short-term. The technology ages on compacting, power efficiency and sensor allegiances with the eventual goal of multidimensional-data capture.

Cloud-Based Analytics and AI Integration

Conventional cloud computing platforms allowed the movement away from just capturing health data to active, real-time, and continuous engagement with health (wearable cardiac devices). Systems were using HIPAA-compliant infrastructure such as encrypted, cloud to stream physiological data at high rates to support real-time clinician/caregiver access (11). The architecture not only delivered on scalability for storage but also enabled remote and asynchronous analytics at scale.

What is an important trend in this space is the utilization of artificial intelligence (AI)/machine learning to analyze the data collected via wearables. Many studies showed that AI algorithms are capable of differentiating arrhythmia, predict decompensated heart failure, and alert a team leader of clinical deterioration in-patient (6, 7). The predictive models were most useful when trained on large and diverse datasets while balancing high sensitivity against specificity in cardiac event detection.

Cloud providers were also able to improve interoperability by linking into electronic health records (EHRs) and the hospital systems together ensuring the data lay in sync and continuity of care was achievable (17). The most common location was in the clinician interface and consisted of embedded decision support systems for automated triage, trend visualization, evidence-based recommendations.

Some of the promising works in federated learning were focused on data privacy preserving and also made successful analytics. Rather than sending the raw data to central servers, these methods trained AI models directly on user devices which could significantly minimize data breaches and meet with modern data security requirements.

Despite these capabilities, the review this paper identified data quality inconsistencies regarding the data that was located latency in providing real time alerts and mentioned issues in standardizing outputs across platforms. The finding emphasizes the importance of harmonizing regulatory practices and having the ability for cross platform standardization to take full advantage of the benefits cloud-based analytics would provide to cardiac care.

Clinical Outcomes and Effectiveness

In summary of the reviewed studies, the findings showed measurable improvements in patient outcomes for all cardiovascular conditions due to wearable cardiac monitoring systems which are integrated either through cloud or locally. Multiple randomized controlled or cohort studies reported decreased hospital readmissions especially in heart failure patients resulting from the use of wearable by itself (8) in hybrid cardiac rehabilitation programs. For patients with atrial fibrillation (AF), early detection using continuous ECG and Photoplethysmography (PPG)-based monitoring allowed for quicker clinical interventions—improving prognosis and reducing stroke risk (3, 5). Cloud platforms expanded the clinical decision-making to be used remotely and as part of real-time interaction with a patient dashboard along with predictive analytics. In real time, AI algorithms appraised data streams to detect cardiac decompensation or arrhythmic events (6, 7). Frequently these tools were connected via interfaces or integrations directly into existing electronic health records, for quick triage alerts and individualized care plans (17). About the health Economics, preliminary Findings With Wearable-Cloud Ecosystems Showed that health-Costs Could Be Reduced in the Healthcare System. Also the costs, fewer ED visits as a consequence of avoiding unnecessary services, less need for in-person follow-up and more efficient outpatient care coordination (18). In addition, the patient experience and engagement with self-monitoring tools was occasionally assessed and found to be high when the wearables were designed for ease of use and comfort (4, 16).

Limitations and Barriers

Integration of intelligent wearables and cloud analytics into cardiac care faces several important challenges even with their promise. One concern is data privacy and security. Sensitive cardiac health information travels over cloud infrastructure. This introduces vulnerabilities when third-party data hosts are involved (11). Compliance with regulations like HIPAA and GDPR remains a persistent hurdle.

Another limitation is patient adherence. Studies reported compliance that was variable, especially in older adults or those with limited digital literacy. This can diminish how effective continuous monitoring protocols are (12). Behavioral fatigue from prolonged wearable use was also noted in some users.

Technical issues reduce data reliability. These include motion artifacts, signal noise as well as limitations in battery life (19). In addition, the lack of interoperability from one device manufacturer and electronic health system to other stifles the seamless application of wearable data into clinical workflows.

The majority of studies had short follow-up periods. Sample sizes were small. The populations studied were not diverse. The need for larger longer-term studies with standardized evaluation metrics is underscored. This is to validate clinical utility.

Summarizes key details from the studies included in this review, highlighting the types of wearable devices used, the cardiac parameters monitored, study designs, and major clinical findings. The table demonstrates the widespread use of smartwatches, ECG patches, and AI-integrated platforms across diverse settings, with outcomes such as improved arrhythmia detection, reduced hospital readmissions, and enhanced remote monitoring capabilities.

Table 1: Table 1: Inclusion and Exclusion Criteria for Study Selection in Review of Cardiac Wearable Technologies with Cloud-Based Analytics (2017–2025)

Category	Inclusion Criteria	Exclusion Criteria
Publication Date	Peer-reviewed articles published between Jan 1, 2017 – Apr 30, 2025	Non peer reviewed articles or before 2017
Study Population	Adult human participants (≥18 years)	Animal studies or pre-clinical trials
Technology Focus	Wearable technologies used for cardiac monitoring	Non-cardiac applications of wearable technology
Technical Component	Must include cloud-based analytics, machine learning, or remote monitoring infrastructure	Studies lacking a cloud analytics component
Outcome Reporting	Reporting of clinical or diagnostic outcomes (e.g., AF detection, hospital readmission)	Lack of data or outcomes
Language & Access	English-language, full-text available	Editorials, opinion pieces, abstracts without full papers, dissertations

Table 2: Summary of Included Studies on Wearable Cardiac Monitoring Technologies with Cloud-Based and AI Components

Author(s)	Country	Study Design	Device Type	Parameters Monitored	Outcomes Reported	Key Findings
Damery et al. 2025	UK	Qualitative Study	App + Wearable	HR, ECG, BP	Hospital readmission, adherence	Hybrid rehab reduced readmissions and improved patient engagement
Saarinen et al. 2023	Finland	Observational	Smartwatch (PPG + ECG)	HR, ECG, AF detection	Diagnostic accuracy	High sensitivity/specificity for AF detection
Poh et al. 2023	Singapore	Algorithm Validation	Wrist-worn device	ECG, PPG	Real-time AF detection	Deep learning model detected AF with 95% specificity
Bacevicius et al. 2023	Lithuania	Diagnostic Study	6-lead wearable ECG	ECG	AF detection	Six-lead wearable showed clinical-grade accuracy
Chang et al. 2023	USA	Machine Learning	Various wearables	ECG, HRV	AI prediction accuracy	AI model achieved >90% accuracy in heart disease detection
Shankar et al. 2023	India	Software Framework	AI platform for ECG	ECG signals	Processing efficiency	CarDS-Plus platform enabled scalable wearable ECG analysis
Li, Wang & Ahmed 2022	Pakistan	Algorithm Testing	Smart patch	ECG, HR	Arrhythmia classification	DNN achieved 98.2% classification accuracy
Wang & Gul 2023	Pakistan	Pilot Study	AI-enhanced wearable	ECG, HR	Usability, rural deployment	Feasible for remote cardiac monitoring in underserved areas
Firouzi & Rahmani 2023	Global	Review	Multi-device systems	ECG, HR, BP, SpO_2	Data architecture, security	Highlighted scalability of cloud-IoT integration in cardiology

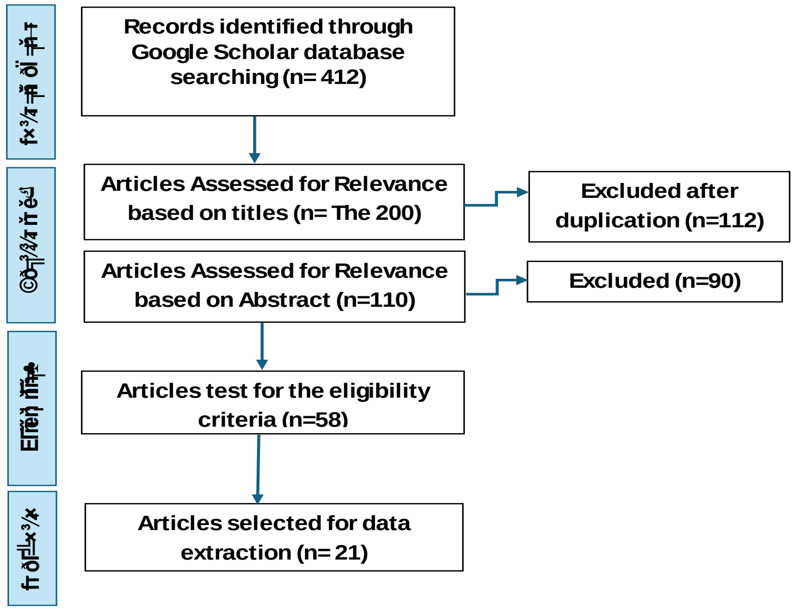

Figure 1: PRISMA Flow Diagram for Systematic Review Study Selection

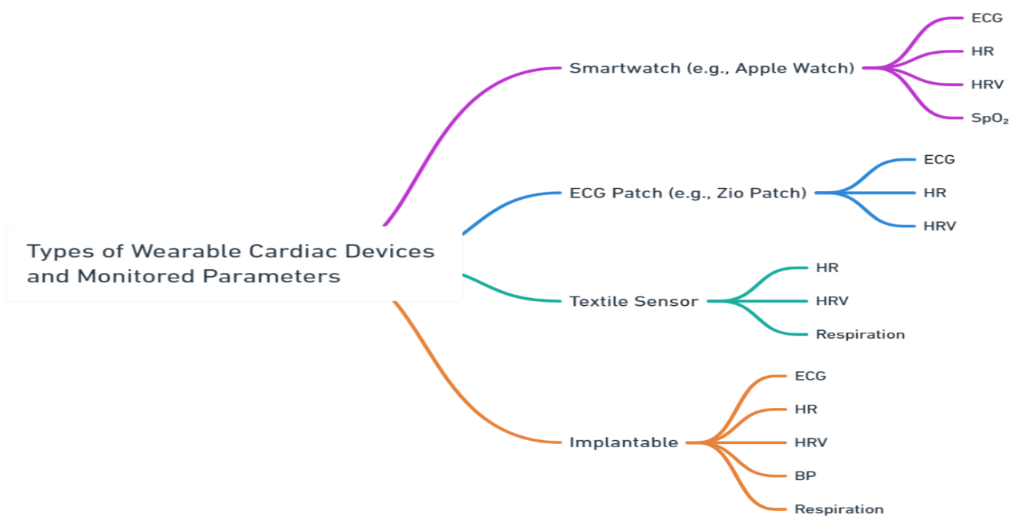

Figure 2: Types of Wearables and Monitored Parameters

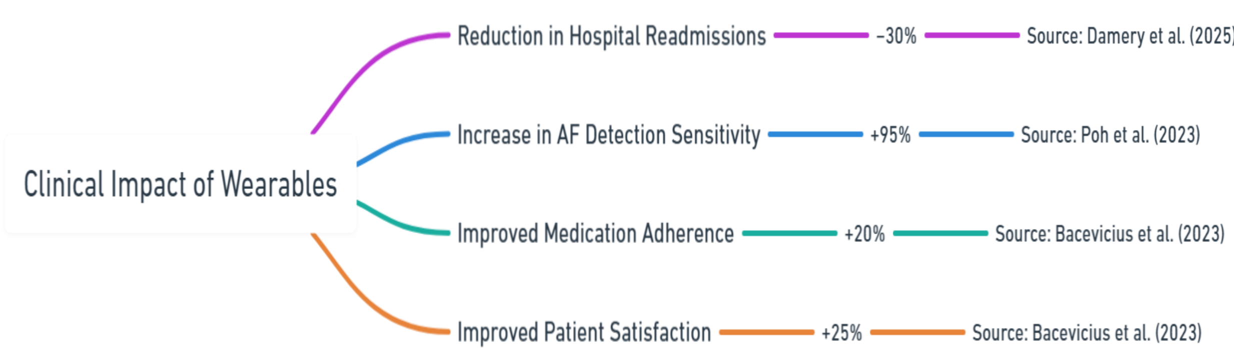

Figure 3: Clinical Impact of Wearable

Discussion

This systematic review underscores the transformative role of intelligent wearables and cloud-based analytics in reshaping contemporary cardiac care. The convergence of real-time physiological data collection with artificial intelligence (AI)-powered analysis represents a fundamental shift from reactive to proactive healthcare. Rather than relying solely on intermittent, in-clinic evaluations, these technologies facilitate continuous, remote monitoring and personalized risk assessment—paving the way for more dynamic and patient-centered cardiovascular management.

Wearable devices with computing capability do not substitute for typical medical treatment. They improve medical treatment using combined care methods. Proof from combined recovery programs, like Active+me REMOTE, shows better results than only normal recovery (8). The programs help find health declines sooner, permit faster treatments as well as lower need for hospital buildings. In this way a load is taken off of emergency rooms. Clinicians treat more people outside of offices, especially for long-term illnesses and care after leaving the hospital.

Wearable and cloud technologies have promise, but systemic and technical problems slow broad use in heart treatment. Data infrastructures are fragmented as well as devices do not interact well with electronic health record systems (9). This presents a large obstacle. A number of healthcare centers do not have fixed procedures for adding wearable data to typical clinical activities. Regulations such as HIPAA plus GDPR require updates for remote data collection and storage specifics. On top of that people must handle ethical concerns. These involve AI-based clinical advice, data ownership next to consent that includes enough information. Addressing those items could develop patient confidence and system responsibility (12).

Evidence shows promise but research still has shortcomings. One need is for studies with many participants over a long time. Such studies can measure the clinical and economic impact of the new technologies long-term. Standard measures for outcomes are also important. They will make it possible to compare studies and technologies in a useful way. Access must be fair. That way disadvantaged people can get the benefits. Future work on design must focus on users, on batteries that last as well as on low maintenance. This will increase ease of use and willingness to follow directions.

Into cardiology practice wearable technologies also cloud infrastructures are going. These changes will help a model of care that predicts, personalizes next to prevents. That model will change how heart disease is watched, handled in addition to soften.

Conclusion

Wearable devices and machine learning algorithms in cloud computing are the current trend in heart health that provides the benefits of real-time and remote monitoring and personalized care. In this article, we present evidence showing that these platforms are instruments for good in the management of patients not only with atrial fibrillation, heart failure, and hypertension but also with other diseases. The use of cloud information along with AI represents a new type of medical care which is based on the high degree of data accuracy and individual needs of the patients.

Still, raising the usage level is possible when technical, ethical, and systemic matters are solved. Forthcoming issues like hospital or clinic connection, device standard setting, as well as data protection reenactment, are indispensable. Besides, the project of reaching both the easy-to-reach and difficult-to-reach groups is demanding yet it is essential to find ways to relieve the inequality of medical care.

To sum up, the use of wearable devices and cloud analytics is changing not only the face of daily medical practice but constantly enabling healthcare professionals to have access to more data and hence a new approach to the control of heart diseases. The potential that lies in both these technologies keeps resonating and its impact on the community only promises a continuous rebirth of cardiology.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
Not Applicable
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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

VG
Manuscript drafting, Study Design,
HD
Review of Literature, Data entry, Data analysis, and drafting article.
PK
Conception of Study, Development of Research Methodology Design, Study Design, manuscript review, critical input.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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