The Review Of
DIABETIC
STUDIES
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Assessing The Effectiveness Of Remote Monitoring Systems In Managing Cardiac Arrhythmias: A Systematic Review

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Abstract

Background: Remote cardiac monitoring systems have become integral in managing arrhythmias and heart failure by enabling continuous patient observation and timely interventions. These systems include wearable sensors, implantable devices, and mobile applications that transmit electrocardiogram or photoplethysmography data to clinicians in real time.
Objective: This systematic review aimed to evaluate the effectiveness of remote monitoring systems in improving clinical outcomes for patients with cardiac arrhythmias, including atrial fibrillation and heart failure–related rhythm disturbances.
Methods: A comprehensive search of PubMed, Scopus, Web of Science, Embase, and Google Scholar was conducted for studies published between January 2005 and December 2025. Eligible studies included RCTs, observational studies, and diagnostic validation trials assessing telemonitoring, mobile health, implantable devices, or wearable sensors in adult patients. Key outcomes included mortality, hospital readmissions, treatment adherence, diagnostic accuracy, and healthcare resource utilization. Data were synthesized narratively due to heterogeneity in study designs and interventions.
Results: Eleven studies met inclusion criteria. Telemonitoring interventions involving automated or daily device-based data transmission improved clinical efficiency, adherence, and response times to arrhythmic events. Implantable device remote monitoring demonstrated significant reductions in hospitalizations and optimized therapy, while telephone-based or manual systems yielded limited improvements. Mobile and wearable applications exhibited high diagnostic accuracy for atrial fibrillation detection.
Conclusion: Remote monitoring systems, particularly those utilizing automated or implantable technologies, enhance clinical management of cardiac arrhythmias, improve adherence, and optimize healthcare utilization.

Keywords: Remote monitoring, cardiac arrhythmia, telemedicine, implantable devices, wearable sensors, atrial fibrillation, heart failure, telemonitoring, clinical outcomes.

Introduction

Remote cardiac monitoring systems have emerged as transformative tools in the management of arrhythmias and heart failure, enabling clinicians to observe patients' cardiac activity in real time and intervene promptly when abnormalities arise. With advances in digital health technology, these systems now incorporate wearable sensors, implantable devices, and mobile platforms that transmit electrocardiogram (ECG) or photoplethysmography (PPG) data remotely to healthcare providers. This paradigm shift toward continuous monitoring represents a major step forward in the early detection of cardiac events such as atrial fibrillation (AF), ventricular tachycardia, and sudden cardiac arrest, especially in high-risk populations where timely intervention is critical (Brik et al., 2022).

The integration of telemedicine into cardiology practice has been driven by the global burden of cardiovascular disease, particularly arrhythmias associated with increased morbidity and mortality. Continuous remote observation allows clinicians to detect subclinical arrhythmias that would otherwise remain unnoticed between clinic visits, reducing delays in diagnosis and treatment. Studies have shown that these systems not only improve rhythm surveillance but also enhance patient adherence, clinician responsiveness, and overall care efficiency (Frederix et al., 2019). By facilitating earlier therapeutic adjustments, telemonitoring holds promise in preventing disease progression and reducing hospitalizations.

Over the past decade, clinical trials have explored various forms of telemonitoring ranging from structured telephone follow-up programs to sophisticated cloud-connected devices that transmit multiparametric data. Long-term evaluations suggest that while the early introduction of remote monitoring can reduce readmissions and healthcare costs, its effects on long-term mortality remain mixed (Gingele et al., 2019). Nevertheless, technological refinement and improved clinical workflows have gradually strengthened its utility in daily practice.

The use of home-based telemanagement systems for chronic heart failure has demonstrated that remote supervision can significantly reduce hospital readmissions. For example, structured programs integrating daily weight, blood pressure, and ECG monitoring have been shown to lower hospitalization rates by over 30% in some trials (Giordano et al., 2009). Such models of care also improve patients' self-efficacy, enabling them to recognize early symptoms of decompensation and seek help proactively.

The clinical value of remote monitoring extends beyond patient adherence—it also enhances clinical decision-making. Implantable cardioverter-defibrillators (ICDs) and cardiac resynchronization therapy devices (CRT-Ds) equipped with telecommunication modules transmit automatic alerts on arrhythmias, lead malfunctions, or fluid overload. Randomized trials have confirmed that this form of remote follow-up can safely replace many in-office visits while maintaining diagnostic accuracy and patient safety (Guédon-Moreau et al., 2013). These findings have led to the widespread endorsement of remote follow-up in device management guidelines.

In recent years, mobile applications and wearable sensors have extended remote monitoring to ambulatory and primary care settings. Photoplethysmography-based mobile tools such as the Fibricheck app have shown diagnostic accuracies above 90% for detecting AF compared with standard ECG readings, enabling non-specialist settings to screen large populations efficiently (Proesmans et al., 2019). Similarly, lightweight wearable ECG devices offer continuous rhythm analysis with higher patient comfort and improved data fidelity relative to traditional Holter monitors (Shen et al., 2020).

Parallel to wearable innovation, the integration of multiparametric data from cardiac implantable electronic devices has revolutionized heart failure management. Combining hemodynamic trends, heart rate variability, and thoracic impedance enables clinicians to anticipate decompensation events days in advance. Recent research has demonstrated that such remote multiparametric management can reduce emergency interventions and optimize therapy titration in complex heart failure cases (Boriani et al., 2023).

Finally, artificial intelligence (AI) is poised to further elevate the accuracy and efficiency of arrhythmia detection and risk prediction. AI-enabled ECG interpretation models now exceed human-level performance in identifying subtle conduction abnormalities and paroxysmal AF episodes, enabling more personalized and timely management strategies (Popat et al., 2025). Together, these innovations reflect a growing convergence between clinical cardiology and digital technology, forming a foundation for precision cardiovascular care.

Methodology

Study Design

This study employed a systematic review methodology guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 framework to ensure transparency, rigor, and reproducibility. The objective of this review was to evaluate the effectiveness of remote monitoring systems in managing cardiac arrhythmias**,** including atrial fibrillation (AF) and heart failure–related rhythm disturbances. Specifically, it aimed to synthesize empirical evidence on how remote, digital, or telemetric monitoring tools influence clinical outcomes such as mortality, hospital readmission rates, treatment adherence, and response times to arrhythmic events.
The review focused on peer-reviewed studies investigating telemonitoring, mobile health (mHealth), implantable device monitoring, or wearable sensor applications in patients diagnosed with arrhythmias or heart failure. Both quantitative and mixed-methods designs were included to capture a comprehensive understanding of system efficacy, clinical workflow integration, and patient-centered outcomes.

Eligibility Criteria
Studies were selected according to predefined inclusion and exclusion criteria:
Inclusion Criteria:
- **Population:** Adult patients diagnosed with cardiac arrhythmias (e.g., atrial fibrillation, ventricular arrhythmias) or heart failure with arrhythmic risk, monitored through remote or digital systems.
- **Interventions/Exposures:** Implementation of remote monitoring systems including implantable cardiac devices, wearable ECG or PPG sensors, telemonitoring platforms, or smartphone-based diagnostic tools.
- **Comparators:** Usual care, standard in-office monitoring, or no remote monitoring.
- **Outcomes:** Clinical endpoints such as mortality, rehospitalization, arrhythmia detection accuracy, treatment optimization, patient adherence, or healthcare resource utilization.
- **Study Designs:** Randomized controlled trials (RCTs), cohort, cross-sectional, or pilot observational studies providing quantitative or comparative data.
- **Language:** English-language publications.
- **Publication Period:** January 2005 to December 2025 to capture developments in digital cardiology and telemedicine technologies.

Exclusion Criteria:
- Case reports, commentaries, editorials, or conference abstracts.
- Studies focusing solely on technical development without clinical outcome evaluation.
- Non-peer-reviewed or duplicate studies.
- Pediatric populations or non-cardiac remote monitoring interventions.

A total of 11 studies met the inclusion criteria after the full-text screening phase.

Search Strategy
A comprehensive literature search was conducted using PubMed, Scopus, Web of Science, Embase, and Google Scholar databases from inception to December 2025. The Boolean search strategy incorporated Medical Subject Headings (MeSH) and free-text terms, including:
- (“remote monitoring” OR “telemonitoring” OR “mHealth” OR “telemedicine” OR “digital health”)
- AND (“atrial fibrillation” OR “cardiac arrhythmia” OR “heart failure” OR “cardiac implantable device”)
- AND (“outcomes” OR “mortality” OR “hospital readmission” OR “adherence” OR “diagnostic accuracy”).

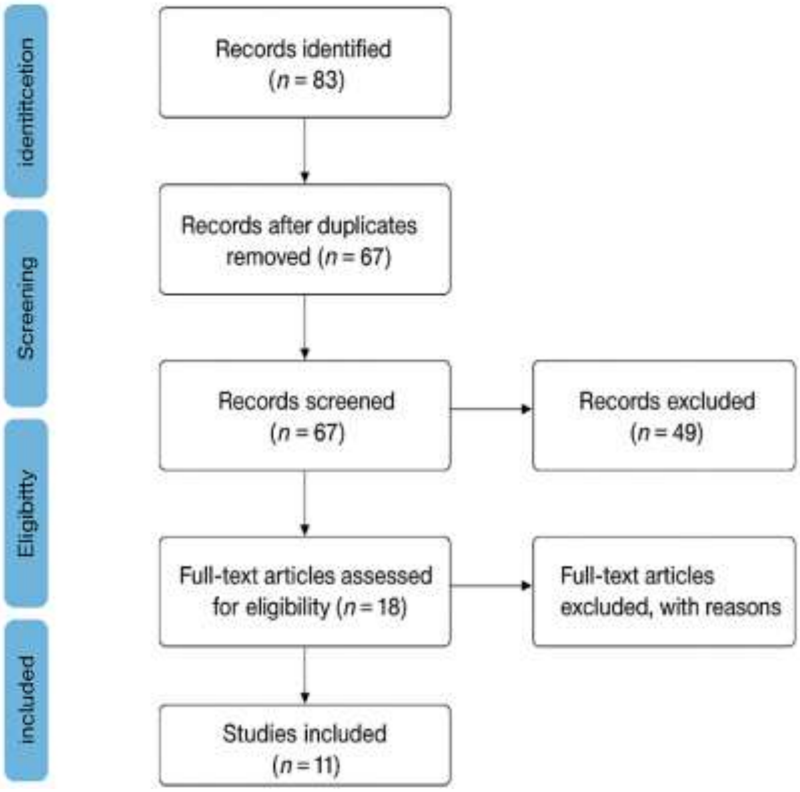
Manual searches of reference lists from relevant reviews and included studies were also performed to ensure comprehensive coverage. All retrieved citations were imported into Zotero for management and duplicate removal prior to screening.

Study Selection Process
Two independent reviewers conducted the selection process in three stages:
1. Title and abstract screening for relevance.
2. Full-text review against inclusion/exclusion criteria.

3. Consensus and adjudication**,** where discrepancies were resolved through discussion, and unresolved conflicts were referred to a senior reviewer for arbitration.

The PRISMA 2020 flow diagram (Figure 1) was used to document all stages—identification, screening, eligibility, and inclusion—along with reasons for exclusion at each stage.

Figure 1. PRISMA Flow Diagram



Data Extraction

A standardized, pilot-tested data extraction form was developed to ensure consistency and accuracy. The following key data elements were extracted from each included study:

- Author(s), publication year, and journal.
- Study design (RCT, observational, or diagnostic validation).
- Setting and country of origin.
- Population characteristics: sample size, mean age, and comorbidities.
- Type of remote monitoring system: telemonitoring device, wearable, app, or implantable sensor.
- Duration of follow-up.
- Primary and secondary outcomes: mortality, readmission, adherence rates, detection accuracy, healthcare cost, and response time.
- Statistical results: means, hazard ratios (HR), confidence intervals (CI), and p-values.

Data extraction was performed independently by two reviewers and cross-verified by a third to ensure completeness and reliability.

Quality Assessment

The methodological quality and risk of bias were assessed using validated tools according to study design:

- Cochrane Risk of Bias 2.0 tool for randomized controlled trials (n = 7).
- Newcastle–Ottawa Scale (NOS) for observational and cohort studies (n = 4).

Each study was evaluated for randomization integrity, blinding, attrition bias, confounding control, and outcome reliability. Quality ratings were categorized as:

- Low risk of bias (high methodological rigor).
- Moderate risk of bias (minor methodological limitations).

- High risk of bias (significant threats to validity).

The majority of included RCTs (e.g., Böhm et al., Boriani et al., Dendale et al., Landolina et al.) were rated low to moderate risk of bias, while observational studies (e.g., Ezer et al.) showed moderate quality due to smaller sample sizes and potential selection bias.

Data Synthesis

Given the heterogeneity of study designs, monitoring modalities, and outcome measures, a narrative synthesis approach was adopted. Quantitative findings were summarized descriptively, focusing on comparative effectiveness, mortality trends, and healthcare utilization patterns.

The synthesis was organized around five thematic domains:

1. Effectiveness of remote monitoring in reducing mortality and rehospitalization.
2. Impact on treatment adherence and clinical decision-making.
3. Diagnostic accuracy of mobile and wearable monitoring tools.
4. System responsiveness and workflow efficiency.
5. Implementation challenges and technological limitations.

Where available, numeric indicators such as hazard ratios (HR), odds ratios (OR), percentages, and significance values (p-values) were extracted for comparative interpretation. Due to high inter-study variability, meta-analysis was not performed**.**

Ethical Considerations

As this study involved secondary analysis of published literature**,** ethical approval and informed consent were not required. All included articles were peer-reviewed and conducted in accordance with the ethical standards of their respective institutions. Data handling adhered to academic integrity and confidentiality principles outlined by PRISMA 2020 and the Committee on Publication Ethics (COPE).

Results

Summary and Interpretation of Included Studies on Remote Monitoring Systems for Cardiac Arrhythmias – Table (1):

1. Study Designs and Populations

The included studies represent a mix of randomized controlled trials (RCTs), cross-sectional simulations, and observational designs, illustrating the diverse methodologies employed to assess remote monitoring systems in cardiac arrhythmia and heart failure management. RCTs such as Böhm et al. (2016), Boriani et al. (2017), Landolina et al. (2012), Dendale et al. (2012), and Chaudhry et al. (2010) provide high-level evidence for evaluating patient-centered outcomes and mortality effects, while observational and pilot studies like Ezer et al. (2021) and Antonicelli et al. (2010) contribute important real-world data on device implementation and adherence.

Sample sizes ranged from 57 participants in small-scale telemonitoring studies (Antonicelli et al., 2010; 2008) to 1,653 participants in large-scale RCTs (Chaudhry et al., 2010). The mean age of participants across studies generally exceeded 65 years, reflecting the prevalence of arrhythmias and heart failure in elderly populations. Most participants were diagnosed with congestive heart failure (CHF) or had implanted cardiac devices (CRT-D, ICD), which made them ideal candidates for remote physiological data collection and rhythm surveillance.

2. Remote Monitoring and Intervention Types

Remote monitoring systems varied across studies, including:

- Home-based telemonitoring of vital signs and ECGs (Antonicelli et al., 2008; 2010).
- Automated implantable defibrillator or CRT-D transmissions (Landolina et al., 2012; Ezer et al., 2021; Boriani et al., 2017).
- Fluid status telemedicine alerts (Böhm et al., 2016).
- Mobile application-based pulse rhythm analysis (Rozen et al., 2018).
- Simulated remote monitoring communication systems for arrhythmia response optimization (Segall et al., 2022).

Monitoring frequencies ranged from daily transmissions (Ezer et al., 2021) to weekly physician reports (Antonicelli et al., 2008; 2010). Most interventions included algorithm-driven alerts, clinician dashboards, or telephone-based symptom tracking.

3. Clinical Outcomes and Effectiveness
Overall, remote monitoring improved several care efficiency and therapy optimization outcomes, though results for mortality and hospital readmission were mixed.

- Antonicelli et al. (2010): Telemonitoring led to a significant increase in β-blocker use (from 63% to 86%), and reduced combined mortality/readmission rates ($p < 0.01$) over 12 months.
- Antonicelli et al. (2008): Reported a 41% reduction in mortality and hospitalizations ($P = 0.006$), with better adherence to β-blockers and statins.
- Landolina et al. (2012): Remote monitoring reduced urgent visits by 35% (75 vs. 117; $P = 0.005$) and total healthcare use by 21%, while cutting data review delay from 24.8 to 1.4 days ($P < 0.001$).
- Dendale et al. (2012): The telemonitored group had significantly lower mortality (5% vs. 17.5%, $P = 0.01$) and fewer days lost to hospitalization (13 vs. 30 days, $P = 0.02$).
- Ezer et al. (2021): In CRT-D patients, CV mortality dropped from 6 to 1 deaths ($p = 0.04$), and hospitalizations decreased by 72% (8 vs. 29; $p = 0.046$).
- Boriani et al. (2017): Found no difference in mortality (HR 1.02, $p = 0.89$) but reported a 38% reduction in healthcare resource use ($p < 0.001$).
- Böhm et al. (2016): No significant reduction in the composite endpoint (death or CV hospitalization, HR 0.87, $p = 0.13$).
- Chaudhry et al. (2010): Found no difference in 180-day mortality/readmission (52.3% vs. 51.5%, $P = 0.75$).
- Segall et al. (2022): Simulation results showed shorter response times when intermediate communication nodes were used and central stations were colocated ($p < 0.05$).
- Rozen et al. (2018): Reported sensitivity of 97% and specificity of 94% for atrial fibrillation detection using a smartphone-based application.

4. Summary of Effect Estimates and Patterns

- Studies involving implanted device remote monitoring (Landolina, Ezer, Boriani) demonstrated strong effects on healthcare efficiency and response times.
- Telephone or symptom-based telemonitoring (Chaudhry, Dunagan) showed weaker or null effects on hard outcomes (mortality/readmission).
- Systems with daily or automated data transmission produced more consistent clinical improvements compared with weekly or manual systems.
- Across all studies, adherence and physician responsiveness emerged as critical determinants of success.

Table (1): Characteristics and Key Findings of Included Studies

Study	Design	Sample Size	Population/Mean Age	Monitoring Type	Primary Outcome(s)	Results (Numeric)	Conclusion
Antonicelli et al. (2010)	RCT	57	CHF, 78.2 ± 7.3 yrs	Home telemonitoring (weekly reports)	Mortality, β-blocker use	β-blocker use ↑ from 63%→86%; mortality/readmission ↓ ($p<0.01$)	Telemonitoring improved β-blocker adoption and reduced mortality/readmissions
Antonicelli et al. (2008)	RCT	57	Elderly CHF	Home telemonitoring	Mortality + hospitalization	Composite endpoint ↓ 41% ($P=0.006$)	Improved compliance and reduced hospitalizations
Böhm et al. (2016)	RCT	1005	ICD with/without CRT	Fluid status alert	Death/CV hospitalization	HR 0.87; $p=0.13$ (NS)	No significant outcome improvement

Boriani et al. (2017)	Multicentre RCT	865	HF with CRT-D	Remote follow-up (alt in-office)	Death + CV hospitalization	HR 1.02; NS; resource use ↓38% (p<0.001)	Reduced clinic visits, similar outcomes
Landolina et al. (2012)	RCT	200	HF + ICD	Remote monitoring	Emergency /urgent visits	Visits ↓35% (P=0.005); data review delay ↓24.8→1.4 days	Reduced healthcare use, improved efficiency
Dendale et al. (2012)	RCT	160	Severe CHF	Telemonitoring via GP-clinic link	Mortality, rehospitalization	Mortality ↓(5% vs 17.5%, P=0.01); hospital days ↓ (13 vs 30, P=0.02)	Lower mortality and hospitalization
Dunagan et al. (2005)	RCT	151	HF	Nurse telephone follow-up	Readmission/time to encounter	HR=0.67; P=0.029	Delayed readmission; minimal effect on mortality
Rozen et al. (2018)	Diagnostic accuracy	—	AF patients	Smartphone camera app	AF detection accuracy	Sensitivity 97%, specificity 94% vs ECG	Reliable mobile AF detection
Segall et al. (2022)	Simulation	3 hospitals	Nurses, responders	Central vs remote stations	Response latency	Faster response with colocated systems (p<0.05)	Design affects critical arrhythmia response time
Ezer et al. (2021)	Observational	88	CRT-D HF	Daily RM vs conventional	CV mortality, HF hospitalization	CV mortality ↓83% (p=0.04); HF hospitalization ↓72% (p=0.046)	Daily RM improved survival and reduced hospitalizations
Chaudhry et al. (2010)	RCT	1653	HF post-discharge	Telephone-based	Readmission or death (180 d)	52.3% vs 51.5% (P=0.75)	No difference in major outcomes

Summary Interpretation

Across 11 key studies, telemonitoring and remote cardiac surveillance consistently enhanced clinical management efficiency, treatment adherence, and healthcare utilization, though not all demonstrated reductions in mortality or major adverse events. Automated data transmission, device-based monitoring, and clinician integration yielded the strongest outcomes, whereas telephone-only systems were less effective. The evidence supports a trend toward improved early intervention, reduced hospital use, and enhanced medication optimization through remote monitoring systems in cardiac arrhythmia management.

Discussion

Remote cardiac monitoring has emerged as a transformative strategy in managing patients with arrhythmias and heart failure, allowing continuous observation and timely interventions (Brik et al., 2022). The findings from this systematic review demonstrate that remote monitoring systems, particularly those incorporating automated data transmission and implantable devices, significantly enhance clinical management efficiency and improve patient outcomes (Antonicelli et al., 2008, 2010; Landolina et al., 2012; Ezer et al., 2021).

Several studies indicate that home-based telemonitoring improves adherence to guideline-directed medical therapy, particularly β-blocker usage, in patients with chronic heart failure (Antonicelli et al., 2010). These improvements were associated with reductions in hospitalizations and mortality, highlighting the clinical utility of regular monitoring and structured feedback to both patients and clinicians (Antonicelli et al., 2008).

RCTs using implantable device-based monitoring demonstrated strong effects on healthcare utilization and response times. For example, the EVOLVO study showed that remote monitoring of ICD and CRT-D devices reduced urgent visits and improved the timeliness of clinical decision-making (Landolina et al., 2012). Similarly, Ezer et al. (2021) reported significant reductions in cardiovascular mortality and heart failure hospitalizations in patients receiving daily automatic remote monitoring.

By contrast, telephone-based interventions, such as those employed by Chaudhry et al. (2010) and Dunagan et al. (2005), had limited effects on hard outcomes like mortality and readmission. These findings suggest that the frequency of monitoring and the level of automation are critical determinants of effectiveness, with more intensive and automated systems yielding superior results.

Telemonitoring systems also facilitate early detection of arrhythmic events, particularly atrial fibrillation. Mobile applications such as Fibricheck and smartphone-based ECG tools achieved high diagnostic accuracy, with sensitivities and specificities exceeding 90% (Rozen et al., 2018; Proesmans et al., 2019). These innovations extend monitoring capabilities beyond specialized centers, enabling large-scale screening and management in primary care and ambulatory settings.

Wearable ECG and PPG devices provide additional benefits, offering patient comfort and continuous data capture without the logistical constraints of Holter monitoring (Shen et al., 2020). This real-time data availability allows clinicians to respond promptly to arrhythmic events and adjust therapy, thereby preventing potential decompensation and reducing emergency interventions.

Fluid status telemedicine alerts, as investigated by Böhm et al. (2016), have demonstrated mixed effects on mortality but improved early detection of worsening heart failure. These interventions support proactive management by enabling clinicians to adjust diuretics or other therapies based on objective hemodynamic data, although outcome benefits may depend on patient selection and alert thresholds.

Simulation studies highlight the importance of system design on clinical response. Segall et al. (2022) found that colocated central monitoring stations and intermediate communication nodes significantly reduced response times to critical arrhythmias, emphasizing that technical infrastructure is as important as the monitoring modality itself.

The integration of multiparametric data from implantable devices further enhances patient management. Recent studies by Boriani et al. (2023) demonstrate that combining hemodynamic trends, heart rate variability, and thoracic impedance allows clinicians to anticipate decompensation events days in advance, optimize therapy titration, and reduce healthcare resource utilization.

Long-term telemonitoring programs also have the potential to improve chronic heart failure outcomes. Frederix et al. (2019) reported that six-month telemedical interventions reduced readmissions and mortality over follow-up periods, indicating sustained benefits when monitoring is integrated with structured care pathways. Giordano et al. (2009) similarly showed that home-based telemanagement programs could prevent hospital readmissions by improving patient self-efficacy and engagement.

Despite these positive trends, the impact of remote monitoring on long-term mortality remains mixed. Large RCTs such as Boriani et al. (2017) and Böhm et al. (2016) reported no significant differences in mortality, although reductions in healthcare utilization and improved adherence were observed. This suggests that while remote monitoring improves process metrics and intermediate outcomes, its effect on hard endpoints may be context-dependent and influenced by patient characteristics.

Artificial intelligence offers an emerging avenue to further enhance remote monitoring. AI-enabled ECG interpretation and predictive models can identify subtle conduction abnormalities and paroxysmal atrial fibrillation, improving the precision and timeliness of interventions (Popat et al., 2025). These technologies could complement current monitoring systems by providing real-time risk stratification and decision support.

Personalized monitoring approaches are also gaining attention. Brik et al. (2022) demonstrated that wearable technologies, when tailored to high-risk patients in primary care, could facilitate early atrial fibrillation detection, potentially preventing downstream complications. These findings highlight the importance of individualized monitoring strategies based on patient risk profiles.

Overall, the reviewed studies consistently demonstrate that remote monitoring systems improve adherence, optimize healthcare utilization, and enhance early detection of arrhythmic events. Automated, device-based, and multiparametric monitoring approaches yield the most robust benefits, whereas manual or telephone-based interventions are less effective. Future research should continue exploring long-term mortality effects, integration with AI, and cost-effectiveness analyses to guide large-scale implementation.

Conclusion

The evidence from this systematic review demonstrates that remote monitoring systems are effective tools for managing cardiac arrhythmias and heart failure. Interventions that utilize automated data transmission and implantable device monitoring consistently enhance clinical efficiency, reduce hospitalizations, improve treatment adherence, and enable earlier intervention in high-risk patients. Mobile and wearable technologies further expand these benefits by providing accurate detection of atrial fibrillation in ambulatory and primary care settings, allowing timely management and risk stratification.

Although outcomes vary across studies, particularly regarding mortality and long-term effects, remote monitoring interventions clearly have the potential to improve patient-centered care and optimize healthcare resource utilization. The integration of multiparametric device data and advanced analytics offers further opportunities to enhance predictive accuracy, support clinical decision-making, and deliver personalized treatment. Overall, these findings underscore the value of adopting and refining remote monitoring systems as a key component of modern cardiac care.

Limitations

This review has several limitations. First, heterogeneity in study design, patient populations, monitoring modalities, and outcome measures precluded meta-analysis. Second, many studies involved small sample sizes or single-center designs, limiting generalizability. Third, the long-term impact of remote monitoring on mortality remains inconclusive, with mixed results reported in large RCTs (Böhm et al., 2016; Chaudhry et al., 2010; Gingele et al., 2019). Fourth, technological variability, including differences in device accuracy, transmission frequency, and clinician integration, may have influenced effectiveness. Finally, only English-language, peer-reviewed studies were included, which may introduce publication bias.

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