

## Post-ACS Telecardiology in Hajj Pilgrims: The Impact of Remote Monitoring on Readmission Rates and Clinical Outcomes

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### Article Info

#### Article history:

Received Juni 20, 2026  
 Revised Juni 20, 2026  
 Accepted Juni 21, 2026

#### Kata Kunci:

Telekardiologi,  
 Pemantauan Pasien Jarak Jauh,  
 Sindrom Koroner Akut,  
 Jemaah Haji

#### Keywords:

Telecardiology,  
 Remote Patient Monitoring,  
 Acute Coronary Syndrome,  
 Hajj Pilgrim

### ABSTRAK

Jemaah haji dengan riwayat sindrom koroner akut (ACS) menghadapi peningkatan risiko kekambuhan karena aktivitas fisik yang ekstrem dan paparan panas. Telekardiologi menawarkan pemantauan jarak jauh untuk menjaga stabilitas klinis selama ibadah haji. Tinjauan naratif ini mensintesis publikasi tentang intervensi telekardiologi pasca-ACS pada populasi yang sangat mobile. Tinjauan ini mengevaluasi hasil seperti rawat inap ulang, kejadian kardiovaskular, kepatuhan pengobatan, dan penentu implementasi seperti literasi digital dan konektivitas. Telemonitoring dan telekonsultasi meningkatkan deteksi dini gejala, meningkatkan pengendalian faktor risiko, dan mengurangi rawat inap ulang. Rehabilitasi jantung digital menggunakan perangkat yang dapat dikenakan dan EKG seluler meningkatkan aksesibilitas dan mempercepat triase cepat. Dalam konteks haji, layanan ini mengoptimalkan titrasi obat dan penyesuaian hidrasi. Namun, implementasi yang sukses membutuhkan SOP spesifik konteks, infrastruktur yang andal, integrasi data yang aman, dan strategi untuk menjembatani kesenjangan literasi digital. Telekardiologi terintegrasi dapat mengurangi rawat inap ulang dan meningkatkan hasil klinis bagi jemaah pasca-ACS. Studi perbandingan prospektif selama musim Haji diperlukan untuk mengkonfirmasi efektivitas biaya dan menyempurnakan protokol rujukan lintas batas.

### ABSTRACT

Hajj pilgrims with a history of acute coronary syndrome (ACS) face an increased risk of recurrence due to extreme physical exertion and heat exposure. Telecardiology offers remote monitoring to maintain clinical stability throughout the pilgrimage. This narrative review synthesizes publications on post-ACS telecardiology interventions in high-mobility populations. It evaluates outcomes such as hospital readmissions, cardiovascular events, medication adherence, and implementation determinants like digital literacy and connectivity. Telemonitoring and teleconsultations improve early symptom detection, enhance risk-factor control, and reduce readmissions. Digital cardiac rehabilitation using wearable devices and mobile ECGs improves accessibility and accelerates rapid triage. In the Hajj context, these services optimize medication titration and hydration adjustments. However, successful implementation requires context-specific SOPs, reliable infrastructure, secure data integration, and strategies to bridge digital literacy gaps. Integrated telecardiology can reduce readmissions and improve clinical outcomes for post-ACS Hajj pilgrims. Prospective comparative studies during the Hajj season are needed to confirm cost-effectiveness and refine cross-border referral protocols.

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## 1. INTRODUCTION

Acute coronary syndrome (ACS) remains a major contributor to morbidity and mortality and necessitates intensive post discharge follow up, including ongoing risk of emergency department visits and hospital readmission [6] [11]. In the Hajj setting, pilgrims with a history of ACS are exposed to situational stressors such as heat exposure, dehydration, high physical exertion, altered sleep patterns, and high density mobility, compounded by limited access to specialist care [5]. This combination increases the need for proactive monitoring to enable early detection of ischemic symptoms or arrhythmias.

Telecardiology, delivered through remote physiological monitoring, structured teleconsultations, self-management education, and rehabilitation support, is particularly relevant for highly mobile populations. Prospective evidence from the Hajj season suggests that post-ACS Remote Patient Monitoring (RPM) can facilitate earlier discharge and reduce return visits and readmissions compared with historical benchmarks, although without a contemporary comparator group [1]. Outside the Hajj context, telemedicine for cardiovascular disease has been reported to improve risk factor control, reduce hospitalizations in selected populations, and expand access to digital cardiac rehabilitation [4] [6] [9] [11] This article aims to provide a narrative review of telecardiology after ACS and to synthesize implementation implications for Hajj pilgrims, including key determinants such as digital literacy, connectivity, system interoperability, and data governance [8].

## 2. METHOD

This study is a narrative review of publications evaluating telecardiology or telemedicine for care after acute coronary syndrome or for the management of cardiovascular conditions requiring ongoing monitoring. The review focused on outcomes including hospital readmission, hospitalization, cardiovascular events, medication adherence, participation in rehabilitation, and implementation feasibility.

Relevant articles were identified through bibliographic databases and electronic journal sources, then purposively selected to represent key telecardiology modalities, including remote physiological telemonitoring, scheduled teleconsultations, digital cardiac rehabilitation, and the use of wearable devices. Data were descriptively extracted on study design, population, intervention components, comparators, and principal findings, and subsequently synthesized using a thematic approach. Implementation considerations assessed included digital literacy, connectivity quality, system interoperability, data governance, and the need for clear clinical escalation mechanism [8] [10].

## 3. RESULT AND DISCUSSION

### 3.1 Characteristics of the Included Evidence

The reviewed evidence comprised a prospective observational study conducted during the Hajj season, [1] a pragmatic telemedicine intervention using structured telephone follow up, [2] and systematic reviews and meta-analyses examining telemedicine for cardiovascular disease [4][6][11].

Intervention modalities varied, ranging from device based remote monitoring with symptom reporting, periodic teleconsultations, to digital cardiac rehabilitation programs.

Table 1. Summary of Telecardiology and Telemedicine Studies Related to Cardiovascular Outcomes.

Author (year)	Design	Population	Intervention	Comparison	Key Findings
Khaled et al. (2025/2026)	Prospektive Observational	100 ACS patients during the Hajj Season 1445H	Post discharge with RPM symptom management	Historical Benchmark	Feasible; enabled earlier discharge; low readmission and emergency department revisits
Gherman et al. (2025)	Controlled Prospective (quasi-experimental)	Adult with $\geq 1$ cardiovascular risk factor	Simple Telemedicine: monthly structured telephone cell for 6 months	Standart Care	Improvement in selected outcmes (e.g., diastolic blood pressure, LDL) and follow up adherence.
Asadi et al. (2024)	Scoping review	Cardiovascular disease management during tha pandemic session	Teleconsultation, telemonitoring, <i>wearable</i> , mHealth	Conventional Care	Improved access; clinical outcomes heterogeneous across studies
Laksono et al. (2021)	Systematic review	Heart Failure Patients	Home Based Telemedicine	Usual Care	Most studies report reduced hospitalizatio; mortality effet variable; quality life and adherence improved
Han et al. (2021)	Systematic review & meta-analysis	Cardiovascular Diseases Patients (RCT)	Telemedicine Program for Health Management	Usual Care	Improvement in Systolic Blood Pressure and Quality of Life; Substantial Intervention Heterogenity
Perez et al. (2019)	Large Scale Pragmatic Study	Smartwatch Users	Irregular Pulse Notification with ECG Confirmation	—	Supports feasibility of wearables for arrhythmiad detection
Wongvibu Isin et al. (2021)	Systematic review	Cardiac Rehabilitation Participants	Digital Rehabilitation Interventions	Conventional Rehabilitation	Expanded access and engagement potential improvement in fitness and exercise adherence
Smith & Magnani (2019)	Conceptual Review	General population/patic nt	Digital Health Literacy Framework	—	Digital divide may exacerbate in inequities in

Author (year)	Design	Population	Intervention	Comparison	Key Findings
Kalwani et al. (2022)	Observational Study	Cardiovascular outpatient visits	Telemedicine adoption during the pandemic	In person visits	access and benefit from telehealth Marked increase in telemedicine utilization, altering patterns of care access

### 3.2 Readmission and Hospitalization Outcomes

In the prospective Hajj season study, post-ACS RPM was reported to facilitate earlier discharge and was associated with low rates of hospital readmission and emergency.

### 3.3 Digital Cardiac Rehabilitation

Digital cardiac rehabilitation interventions expand accessibility and improve patient engagement, particularly when geographic and logistical barriers limit conventional rehabilitation [9]. Common components include education, activity tracking, periodic feedback, and behavioral support to strengthen exercise adherence.

### 3.4 Discussion

The available evidence supports the clinical rationale for telecardiology among Hajj pilgrims after acute coronary syndrome, namely maintaining continuity of care and minimizing delays in responding to symptoms. A prospective study conducted during the Hajj season indicates that remote patient monitoring can be implemented in a department revisits [1]. Across cardiovascular populations more broadly, several systematic reviews and meta-analyses reported reductions in short term hospitalization in selected groups; however, the consistency of mortality benefit remains variable [4] [6] [11].

#### 3.4.1 Implementation Factors in Highly Mobile Populations

Implementing telecardiology for Hajj pilgrims require reliable communication infrastructure, secure integration of monitoring data, clear clinical escalation pathways, and protocols for triage and referral across facilities [1] [5]. Recurrent barriers in the telemedicine literature include variability in digital literacy, uneven connectivity, and challenges related to system interoperability.<sup>10</sup> mass gathering situation and may help reduce service burden [1]. However, the absence of a contemporary comparator requires prospective controlled studies to confirm the magnitude of clinical and economic benefits. Scheduled teleconsultations and self-monitoring may facilitate medication titration, adjustment of activity and hydration, and reinforcement of medication adherence throughout the pilgrimage. A simple telephone-based telemedicine intervention has been shown to be feasible and to improve selected metabolic and cardiovascular outcomes in at-risk populations, making it particularly relevant for groups with limited digital literacy [2] [8]. In contrast, metaanalyses broader cardiovascular disease populations report improvements in blood pressure and quality of life, although substantial intervention heterogeneity limits generalizability [6] [11].

With respect to rehabilitation, digital approaches can expand access and improve engagement [9]. The integration of wearable devices and mobile ECG recordings may support early alerts and rapid triage when symptoms occur, while ensuring attention to diagnostic accuracy, data security, and clearly defined clinical escalation pathways [7]. This review is limited by its narrative design and the purposive selection of literature without a systematic review protocol; therefore, selection and publication bias remain possible. Nevertheless, this thematic synthesis provides a practical foundation for developing context specific telecardiology protocols for post-acute coronary syndrome care during the Hajj season.

#### 4. CONCLUSION

Telecardiology after acute coronary syndrome may reduce readmissions and improve clinical outcomes among Hajj pilgrims when integrated into a package of physiological monitoring, scheduled teleconsultations, and, rehabilitation support.<sup>1,9</sup> Prospective comparative studies during the Hajj season are required to verify the magnitude of clinical and cost effects and to refine cross border triage and referral protocols.

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