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Management Strategies of Atrial Fibrillation Detected by Consumer Wearable Devices: A Systematic Review of Clinical Practice and Decision-Making

REVIEW

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ABSTRACT

Consumer-grade wearable devices using photoplethysmography (PPG) and single-lead electrocardiography (ECG) are increasingly used to detect irregular rhythms suggestive of atrial fibrillation (AF) in ambulatory, asymptomatic populations. While these technologies have expanded opportunities for early AF detection, their rapid adoption has outpaced the development of standardized management pathways, and it remains unclear how a PPG-based notification, a patient triggered single-lead ECG tracing, and a continuously recorded ambulatory ECG patch should be evaluated in practice.

A systematic search of MEDLINE, the Cochrane Library, and Google Scholar identified literature published from January 2015 through December 2025. Ten studies met eligibility criteria: one randomized clinical trial, five prospective or retrospective observational studies and single-arm studies, and four clinician surveys. Patient-level studies demonstrated high actionability of wearable alerts, with 57% to 83.5% of alert recipients seeking medical follow-up. Among patients whose alerts were subsequently confirmed as AF, direct oral anticoagulation initiation varied widely from 12% to 90%, reflecting differences in population risk, confirmation method, and reporting denominators rather than a single consistent practice. Survey data revealed a parallel lack of consensus: 99.5% of physicians required traditional diagnostic confirmation before treatment, yet thresholds for the AF duration warranting anticoagulation ranged from 5 to 6 minutes (15% of clinicians) to more than 24 hours (34%). Management also varied by specialty, with emergency medicine physicians more than twice as likely as primary care physicians to refer to a specialist. Building on these patterns, we propose a conceptual clinical pathway requiring prospective validation that integrates confirmatory diagnostic testing with risk-stratified management to help close this guideline-practice gap.

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INTRODUCTION

Atrial fibrillation (AF) is the most prevalent sustained arrhythmia in global clinical practice, affecting upwards of 50 million individuals, and represents a critical public health challenge as a primary driver of cardiovascular mortality and rising healthcare expenditures.[1,2]

Individuals with AF face a 5-fold increase in ischemic stroke risk. Traditionally, diagnosis relied on symptom-driven encounters and the gold-standard 12-lead ECG, requiring a physician-interpreted rhythm strip of at least 30 seconds. However, due to the frequently paroxysmal and asymptomatic nature of AF, it often evades detection during routine clinical encounters.[3,4]

The term "wearable-detected AF" is often used to describe several conceptually and diagnostically distinct signals. A photoplethysmography (PPG)-based irregular rhythm notification generated by an optical pulse sensor on a smartwatch or fitness band is a screening alert that requires independent confirmation and carries no diagnostic weight on its own. A single lead ECG tracing, whether patient triggered on a smartwatch or recorded on a consumer adhesive patch, provides a rhythm strip that a clinician can interpret directly, although it lacks the diagnostic certainty of a 12-lead ECG. Ambulatory monitoring (Holter recorders, prescription-grade ECG patches) provides continuous, diagnostic-grade recording comparable to that used to define device-detected subclinical atrial fibrillation (SCAF) or atrial high rate episodes (AHRE) on implanted pacemakers, defibrillators, and loop recorders. This review focuses on consumer, non-implanted detection modalities: PPG notifications, patient-facing single-lead ECG, and consumer ambulatory patches and distinguishes these from implanted device detected SCAF/AHRE since the two differ in diagnostic certainty and rely on different evidence bases for anticoagulation.

A critical distinction has emerged between clinical AF and SCAF, defined as asymptomatic, short-duration episodes captured incidentally by long-term monitors, implanted devices, or consumer wearables. The two leading guidelines diverge in how precisely they define an actionable threshold. The 2023 American College of Cardiology (ACC)/American Heart Association (AHA)/American College of Chest Physicians (ACCP)/Heart Rhythm Society (HRS) guideline stratifies device detected AHRE by duration and risk, where oral anticoagulation (OAC) is not recommended for episodes under 5 minutes without another indication; for episodes lasting 5 minutes to 24 hours with a CHA_2DS_2-VASc ≥ 3 (or equivalent risk), initiating OAC within a shared decision-making framework may be reasonable (Class 2b); and for episodes ≥ 24 hours with a CHA_2DS_2-VASc ≥ 2, OAC is reasonable (Class 2a).[5] The 2024 European Society of Cardiology guidelines by contrast does not specify a duration threshold at all, offering only a Class 2b recommendation that OAC may be considered in selected high-risk patients with formally confirmed asymptomatic AF while acknowledging that subclinical AF carries a 6% to 9% annual risk of progressing to clinical AF.[6] Both frameworks were developed primarily from evidence in implanted device detected populations rather than consumer wearable alerts, a distinction we return to in the Discussion section.

Digital health advancements have restructured arrhythmia detection through widespread adoption of consumer-grade wearables.[7,8] Landmark trials, including the Apple Heart and Fitbit Heart studies, demonstrated that PPG-based irregular pulse notification has a positive predictive value of 0.84 for concurrently confirmed AF, although the overall yield is low since only 0.52% of participants ever received a notification, and just over one-third of those who returned confirmatory ECG monitoring were found to have AF.[9,10] By utilizing PPG and single-lead ECG, wearables facilitate continuous ambulatory surveillance, shifting the responsibility for initial detection from the clinical setting to the patient and enabling identification of previously unrecognized AF in large asymptomatic populations. However, this transition creates significant diagnostic ambiguity, forcing clinicians to decide whether digital alerts warrant the same aggressive treatment as clinical AF.[11-14]

Despite this rapid expansion, no systematic review has fully evaluated the clinical assessment frameworks informing management of wearable-detected arrhythmia. This review addresses these inconsistencies by synthesizing literature on the evaluation and treatment of adults identified via wearable technology, integrating patient-level data and clinician surveys to characterize real-world clinical decision-making and identify evidence gaps requiring a uniform management framework.[15-18]

METHODS

PROTOCOL AND REPORTING FRAMEWORK

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines (Figure 1) and was prospectively registered with the International Prospective Register of Systematic Reviews (PROSPERO; registration number CRD420251266477).

SEARCH STRATEGY

A comprehensive systematic search was performed across three databases MEDLINE (via PubMed), the Cochrane Library, and Google Scholar, restricted to articles published

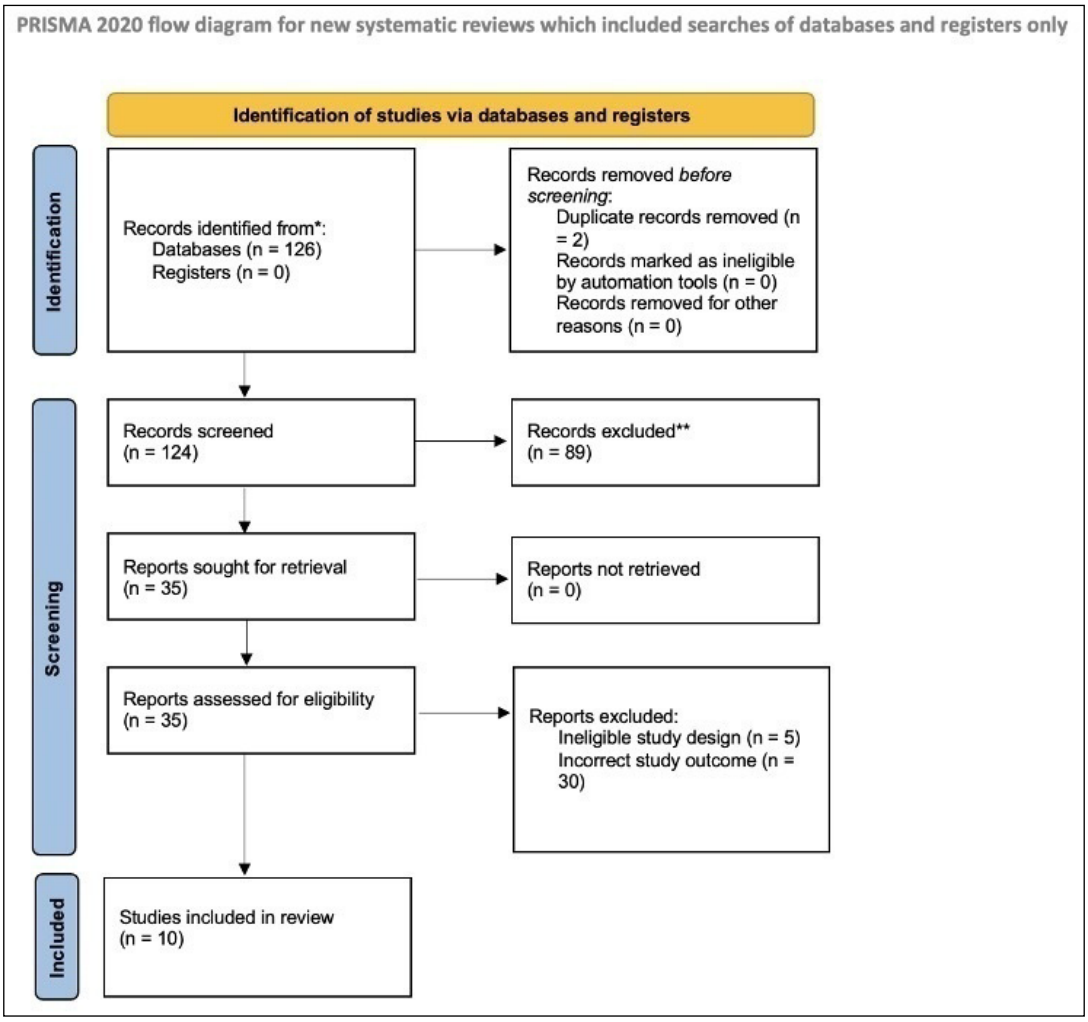


Figure 1 PRISMA flow diagram for article search illustrating initial identification of 126 records, screening, full-text review, and final inclusion of 10 studies. PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

in English between January 1, 2015, and December 31, 2025. The MEDLINE search strategy combined the following concept blocks using Boolean operators: "atrial fibrillation" OR "subclinical atrial fibrillation" OR "atrial high-rate episode") AND ("wearable devices" OR smartwatch OR photoplethysmography OR PPG OR "single-lead electrocardiography") AND ("clinical management" OR anticoagulation OR "physician preferences" OR survey. Analogous strategies, adapted to platform-specific syntax, were applied to Cochrane Library and to Google Scholar. Records identified across databases were exported to a shared reference manager and duplicate records were identified and removed before independent title and abstract screening by three reviewers. Reference lists of included studies were manually screened for additional eligible reports.

ELIGIBILITY CRITERIA (PICO)

Studies were selected based on a predefined PICO framework:

- Population (P): Adults (≥ 18 years) utilizing consumer-grade wearable devices (eg, Apple Watch, Fitbit, Huawei) for cardiac rhythm monitoring
- Intervention (I): Detection of an irregular heart rhythm notification or a wearable-captured AF alert
- Comparison (C): Standard clinical diagnostic pathways (eg, 12-lead ECG, Holter monitoring) or clinician responses to survey-based clinical vignettes
- Outcome (O): Initiation of OAC, rates of diagnostic confirmation, and downstream healthcare resource utilization

Exclusion criteria: Case reports and narrative reviews were excluded for lack of systematic methodology. Studies reporting only device diagnostic accuracy without management outcomes were excluded, as this evidence base is already well established. Non-English language publications, conference abstracts without an available full text, and studies for which full text could not be retrieved were also excluded.

STUDY SELECTION AND DATA EXTRACTION

Titles and abstracts were independently screened by three reviewers, with conflicts at either the title/abstract or full-text stage resolved through group discussion and, where consensus could not be reached, adjudication by the senior author. Full-text articles were retrieved and reviewed against the eligibility criteria stated above, and the reasons for full-text exclusion (diagnostic accuracy only outcomes, non-English language, unavailable full-text or non-systematic design) were logged for each excluded record. Data were extracted into a standardized spreadsheet capturing study characteristics, participant demographics, limitations, risk of bias, and clinical management metrics.

QUALITY ASSESSMENT (RISK OF BIAS)

Methodological quality was independently appraised by three reviewers using validated instruments tailored to study design: Cochrane Risk of Bias 2 (RoB 2) for randomized controlled trials; Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) for observational studies; Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) for diagnostic accuracy studies; and the McMaster University Risk of Bias Tool for clinician surveys.[19-21]

RESULTS

STUDY SELECTION AND EVIDENCE STRATIFICATION

The initial search identified 126 records. Following deduplication, title/abstract screening and full-text review, 10 studies met inclusion criteria: one randomized controlled trial, five prospective or retrospective observational and single-arm studies, and four clinician-targeted surveys (Tables 1, 2). The full study selection process is demonstrated in the PRISMA diagram shown in Figure 1. Sample sizes ranged from 95 physician respondents to over 400,000 participants in the largest consumer-led screening studies. Studies were conducted in North America, Europe, and Asia.

SUMMARY OF INCLUDED STUDIES

Table 1 summarizes the six patient-level studies spanning three consumer detection modalities: PPG-based irregular pulse notifications confirmed by an ambulatory ECG patch (Apple Heart Study, Fitbit Heart Study), PPG-based smartwatch or smartphone screening confirmed by 12-lead ECG or Holter monitoring (Wang et al., Guo et al., Dutch-GERAF) and a continuously recorded, patient applied single-lead ECG with no PPG component (mSToPS). Table 2 summarizes the four clinician surveys. One survey (Meynet et al.) sampled physicians managing both implanted device detected and consumer wearable detected SCAF, therefore its findings are not exclusively generalizable to consumer wearables and are interpreted with this mixed scope in mind.

OBSERVED CLINICAL MANAGEMENT IN INTERVENTIONAL AND OBSERVATIONAL STUDIES

Patient-level studies demonstrate high rates of clinical engagement following wearable-device alerts, although reported percentages use difference denominators across studies. In the Apple Heart Study, among all participants who received a PPG-based irregular pulse notification, 57% initiated a telehealth consultation or saw a primary care provider (PCP), 33% were referred for specialist consultation, 36% underwent secondary cardiac testing, and 24% reported a subsequent cardioversion procedure.[12] The mSToPS trial, which used a continuously recorded single-lead ECG patch rather than a PPG alert, reported an 83.5% PCP follow-up rate among participants with newly detected AF.[22]

Diagnostic yield and therapy initiation varied substantially by population, detection modality, and denominator. In a large-scale Chinese cohort using smartphone-based PPG screening, 87% of suspected AF notifications were confirmed via formal medical evaluation, and 79.6% of these confirmed patients were started on direct oral anticoagulants (DOAC) based on CHA_2DS_2-VASc and HAS-BLED scores.[23] The Dutch-GERAF study, which screened geriatric patients with PPG followed by 12-lead ECG confirmation, reported DOAC initiation in 90% of confirmed cases.[24] In contrast, Wang et al. studied an older, retrospective PPG-monitored cohort and initiated DOAC in only 12% of confirmed cases.[25] This near 8-fold range illustrates that these studies differ in population risk profile, confirmation method, and the denominator used to define "confirmed cases" and should not be summarized as a single consistent rate.

Clinician-reported Management Preferences and Specialty Discrepancies

Survey data involving over 1,000 physicians revealed near-universal reliance on additional diagnostic testing yet profound lack of consensus on treatment thresholds. Nearly all surveyed clinicians (99.5%) opted for further diagnostic testing following a wearable alert, strongly preferring 12-lead ECG (96.4%) and Holter monitoring (77.1%). Significant variation was observed by specialty: PCPs demonstrated more conservative management, with only 14% opting for immediate specialist referral compared to 30% among emergency medicine physicians for identical presentations.[26] In the "wEHRAbles 2" survey,

TITLE	AUTHORS	DESIGN	POPULATION	METHODS	DETECTION MODALITY & CONFIRMATION	FINDINGS	LIMITATIONS	RISK OF BIAS
Association of Wearable Device Use With Pulse Rate and Health Care Use in Adults With Atrial Fibrillation[25]	Wang et al.	Retrospective, propensity-matched cohort	16,320 patients, 65-74 yrs old	Participants were followed for 90 days using wearable PPG devices	Consumer PPG monitoring (smartwatch); no protocolized confirmatory testing	Of the 16,320 patients, only 125 used wearable devices 12% were put on DOAC 20% had a CHA_2DS_2-VASc of < 2 66.4% had a CHA_2DS_2-VASc of > 3 Those in the wearable PPG had more ECG's compared to those who did not have wearable devices	One cannot infer cause and effect from these exploratory, observational results The characteristics and AF severity among individuals using wearables would be different and would be associated with different outcome patterns	Low risk using ROBINS-1
Mobile Photoplethys-mography Technology to Detect Atrial Fibrillation[26]	Guo et al.	Prospective interventional cohort	187,912 individuals ≥ 18 years old acro ss China	AF screening over 14 days using PPG devices Episodes were followed up by PCP with clinical evaluation or 24 hr Holter monitor or ECG	Smartphone-based PPG screening confirmed by ECG or 24-hr Holter	0.23% received "suspected AF" notification 87% of those pts were confirmed AF with full medical history, physical examination, ECG, or 24 hr Holter monitoring 95% of those pts were followed up using AF integrated care including monitoring, symptom tracking using a mobile AF app 79.6% were anticoagulated using CHA_2DS_2-VASc, HAS-BLED and SAMe-T2T2R	38% of individuals with suspected AF who could not be effectively followed up, which would decrease the proportion of identified AF. Did not have real-time 12-lead ECG data synchronized with PPG-based smart devices to simultaneously confirm AF episodes detected on PPG No report on hard outcomes	Low risk using ROBINS-1
Large-Scale Assessment of a Smartwatch to Identify Atrial Fibrillation[12]	Perez et al.	Prospective, single-arm pragmatic study	419,093 participants in USA ≥ 22 yrs old	Participants were followed for 117 days wearing PPG Apple device for irregular rhythm.	PPG irregular-pulse notification confirmed by 1-week ambulatory ECG patch	0.52% of participants had irregular pulse notification 20% of those participants followed up with ECG ambulatory patch to confirm AF and 34% were confirmed Secondary telemedicine was set up to discuss findings 28% were put on medication (22% on warfarin, 36% on DOAC and 2.2% on aspirin) 57% of participants followed up with PCP 36% had additional testing done 33% followed up with a specialist 24% reported undergoing cardio-version, 3% received an implantable loop recorder	Participants did not initiate contact with the study provider after notification and fewer returned ECG patches Relied on the participants' assessments regarding their eligibility for inclusion and regarding outcomes Substantial loss to follow-up results in uncertain validity and generalizability inherent to this design	High risk using QUADAS-2

(Contd.)

TITLE	AUTHORS	DESIGN	POPULATION	METHODS	DETECTION MODALITY & CONFIRMATION	FINDINGS	LIMITATIONS	RISK OF BIAS
Detection of Atrial Fibrillation in a Large Population using wearable devices: The Fitbit heart study[27]	Lubitz et al.	Pragmatic single-arm remote clinical trial	455,699 participants with Fitbit PPG devices ≥ 22 yrs old in USA	Participants were followed for 5 months wearing PPG Fitbit device for irregular rhythm.	PPG irregular-rhythm notification confirmed by 1-week ECG patch	In the case of a detection, participants are notified and asked to contact a telehealth physician who would take history 35% of participants who had irregular arrhythmia detected on wearable device followed up with PCP Followed up with ECG patch worn for 1 week to confirm AF of 1057 participants, 340 had confirmed AF on wearable ECG patch A follow-up with telehealth physician would be conducted to review data from ECG patch, and recommendation would be made to their PCP to modify risk factors or start DOAC based on CHA_2DS_2-VASc A new diagnosis of AF was reported by 256 of 773 (34.2%) respondents who received an IHRD notification and attended an initial telehealth visit	The study relies on participant self-report for enrollment rather than a manual screening process by study personnel	High risk using QUADAS-2
Opportunistic screening for atrial fibrillation among frail older patients, little effort for a high diagnostic yield. Outcomes of the Dutch-GERAF study[28]	Zwart et al.	Prospective multicenter cohort	952 geriatric patients across 6 sites in the Netherlands	Patients referred to the Geriatric Medicine outpatient clinics were screened with ECG's at baseline and followed for 6 months with a PPG device	PPG screening confirmed by 12-lead ECG (within 48 hr)	2.7% of pts were found to have confirmed AF with ECG after notification from PPG, additional 2% had irregular PPG but no confirmatory ECG 90% of the 2.7% of pts w/confirmed AF were started on DOAC 12-lead ECG was the first method of follow up after PPG notification within 48 hrs in all patients 1/20 of the confirmed AF was on Holter monitor 7/20 was via ED visit and ECG	Despite the consider-able size of the cohort, the number of patients with new AF was limited	Low risk using QUADAS-2
Effect of a Home-Based Wearable Continuous ECG Monitoring Patch on Detection of Undiagnosed Atrial Fibrillation The mSToPS Randomized Clinical Trial[29]	Steinhubl et al.	Direct-to-participant RCT + matched observational cohort	2659 individuals	Individuals were followed for 4 weeks wearing at home ECG sensor patch	Continuously recorded, patient-applied single-lead ECG patch (no PPG)	6.7% were found to have AF 5.7% of these individuals were prescribed DOAC 33.5% were followed up with outpatient cardiologist 83.5% were followed up with PCP	only a limited number of eligible individuals invited successfully enrolled Over 2 yrs follow up is not guaranteed	Some concerns using RoB 2

Table 1 Summary of patient level studies evaluating clinical management of consumer wearable-detected atrial fibrillation. DOAC: direct oral anticoagulation; ECG: electrocardiogram; EHRA: European Heart Rhythm Association; PCP: primary care provider; PPG: photoplethysmography; QUADAS-2: Quality Assessment of Diagnostic Accuracy Studies-2; RoB 2: Cochrane Risk of Bias 2; ROBINS-I: Risk of Bias in Non-randomized Studies of Interventions

TITLE	AUTHORS	DESIGN	PHYSICIAN SAMPLE	SCOPE	METHODS	FINDINGS	LIMITATIONS	RISK OF BIAS
Physician Responses to Apple Watch-Detected Irregular Rhythm Alerts[30]	Demkowicz et al.	Case-based physician survey	95 respondents of 636 emailed; 2 US academic centers	Consumer wearable (Apple Watch) alerts	Emailed 636 physicians a 192-question survey about 16 different cases	99.5% of physicians opted to follow up with further diagnostic testing being ECG (96.4%), Holter monitor (77.1%), TTE (32.8%), stress test (9.9%) Using CHA_2DS_2-VASc assessment of stroke risk 84% of PCPs ordered rhythm monitoring and 16% prescribed antiarrhythmics 14% of PCP referred to specialist compared to 30% of emergency medicine physicians	Respondents may have stronger attitudes toward smartwatches than nonrespondents Case scenarios were limited in detail, and other potentially informative clinical cues available in the real-world were not provided Surveyed physicians at two large academic centers, which may limit the generalizability of our findings	Low risk using the McMaster Risk of Bias Instrument for Cross Sectional Surveys
Current Perspectives on Wearable Rhythm Recordings for Clinical Decision-making: the wEHRAbles 2 Survey[20]	Manninger et al.	Cross-sectional survey	539 physicians from 51 countries	Consumer wearable rhythm recordings	An online questionnaire consisting of 22 questions was prepared using the European Heart Rhythm Association (EHRA) infrastructure and distributed to EHRA members	74% of respondents advocate for screening of AF with PPG devices especially around age 60 or with CHA_2DS_2-VASc score of 2 77.2% would follow up with ECG 63% would schedule a consultation 55.9% believe that DOAC should be started using biomarkers, CHA_2DS_2-VASc scores and clinical parameters	Survey was mainly spread through the network of EHRA and participation was completely voluntary, therefore being prone to selection bias	Moderate risk using the McMaster Risk of Bias Instrument for cross-sectional surveys
Physician Preferences in Using Novel Digital Devices for the Management of Atrial Fibrillation—A DAS-CAM III Survey[31]	Manninger et al.	Cross-sectional survey	502 physicians from 30 countries	Consumer wearable/ PPG-detected episodes	An online questionnaire consisting of 22 questions was distributed by EHRA DAS-CAM III participants via their networks as well as via social media platforms regarding specific pt profiles and episodes detected on PPG devices and what management would look like	In symptomatic low-risk patient 28.8% of physicians chose to use > 24 hr Holter monitoring, 27.8% chose to use 24 hr Holter monitor, 25.2% chose to use single lead ECG device and 8.9% opted to monitor via PPG device In asymptomatic high-risk patients, 29.4% chose to follow up in 1 yr, 21.7% chose to follow up with 12-lead ECG, 19% chose to use 24 hr Holter monitor, 10.2% would use single ECG, 10.2% would do >24 hr Holter monitor and 9.8% opted to monitor via PPG device In symptomatic high-risk patient 38% chose >24 hr Holter monitor, 27% would perform Holter for 24 hr, 14.1% would use single-lead ECG, and 8.7% of respondents would use 12-lead ECG, 8.2% opted to monitor via PPG device	Survey was mainly spread through the network of DAS-CAM III participants, and participation was voluntary, therefore being prone to selection bias	Moderate risk using the McMaster Risk of Bias Instrument for Cross Sectional Surveys

(Contd.)

TITLE	AUTHORS	DESIGN	PHYSICIAN SAMPLE	SCOPE	METHODS	FINDINGS	LIMITATIONS	RISK OF BIAS
						Nearly a third of respondents would not perform AF screening in asymptomatic high-risk patients Physicians prefer to use ECG-based (mainly Holter ECGs) over PPG-based devices to diagnose and screen for AF Physicians use a variety of ECG-based devices to confirm PPG-documented tracings suggestive of AF Electrophysiologists would rather use intermittent single-lead ECG monitoring than traditional Holter ECGs for most clinical indications		
Management of device-detected subclinical atrial fibrillation: a European Heart Rhythm Association survey[32]	Meynet et al.	Physician-based survey study	222 physicians from 46 countries	Mixed: implanted-device (CIED) AND consumer wearable-detected SCAF	Physician-based survey with 24 multiple-choice questions	Oral anticoagulation is prescribed according to CHA_2DS_2-VA and AF duration; 34% of the respondents initiate anticoagulation with AF > 24 hr, 26% with AF > 6 hr, and 15% with AF > 5-6 min Majority of responders recommend the use of consumer-based devices to screen for AF mainly in specific situation 42% looked for arrhythmia confirmation with ECG Holter recording, 44 (31%) requested a 12-lead ECG irrespective of the presence of symptoms, and 36 (25%) assessed the patient's symptoms first, and requested a 12-lead ECG only if symptoms were present. Interestingly, only 2% of the responders do not perform other examinations 96% used CHA_2DS_2-VASc or duration of AF to gauge DOAC prescription	Survey was distributed through EHRA channels, thus reaching mostly electrophysiologists who are used to analyze different forms of heart rhythm tracings, and therefore the results may not be generalizable to all physicians Participation was completely voluntary, with possible selection bias. Relatively limited number of respondents	Moderate risk using the McMaster Risk of Bias Instrument for Cross Sectional Surveys

Table 2 Summary of clinician survey studies on the management of wearable and device detected atrial fibrillation. AF: atrial fibrillation; CHA_2DS_2-VASc: congestive heart failure, hypertension, age ≥ 75, diabetes, stroke/transient ischemic attack, vascular disease, age 65-74, sex category; DOAC: direct oral anticoagulation; ECG: electrocardiogram; EHRA: European Heart Rhythm Association; PPG: photoplethysmography

77.2% of physicians indicated they would confirm a wearable detected arrythmia with a formal ECG before treatment, and 55.9% reported basing DOAC initiation on a combination of biomarkers, CHA_2DS_2-VASc score, and overall clinical judgement rather than duration alone.[18] The subsequent DAS-CAM III survey similarly found that management varied by both risk profile and specialty, with electrophysiologists showing a statistically significant preference for intermittent single-lead ECG recordings over traditional 24-hour Holter monitors.[27]

Threshold Gaps and Decision-making Determinants

While 96% of clinicians reported high adherence to the CHA_2DS_2-VASc framework, willingness to initiate DOAC was highly dependent on arrhythmia burden. A significant threshold gap was identified: 34% of physicians required AF duration of > 24 hours before starting DOAC, 26% required > 6 hours, and 15% were willing to initiate therapy for episodes as short as 5 to 6 minutes with the same CHA_2DS_2-VASc score, underscoring the absence of a shared operational definition of "clinically significant" AF burden.[28]

HEALTHCARE RESOURCE UTILIZATION

Beyond initial diagnosis, 16% of surveyed PCPs reported that wearable alerts influenced decisions to initiate antiarrhythmic drugs, suggesting that consumer-grade devices are increasingly driving complex therapeutic decisions traditionally reserved for clinic-detected arrhythmia.[26]

RISK OF BIAS

The Steinhubl et al. randomized clinical trial was categorized as having some concerns due to its open-label nature, although use of objective administrative claims data provided high reliability. The Apple and Fitbit Heart Studies, both prospective single-arm pragmatic studies rather than randomized trials, were identified as high risk for selection bias due to recruitment of self-selected, technology-proficient users. Clinician surveys consistently demonstrated moderate to high risk of bias primarily due to low response rates and specialist-only sampling frames. Only Demkowicz et al. successfully mitigated this by sampling across multiple specialties. Nonrandomized observational studies by Wang et al. and Guo et al. showed low risk of bias through propensity-score matching and large-scale cohort integration.[22,23,25,26]

DISCUSSION

The findings of this systematic review underscore a transformative shift in AF detection driven by consumer-grade wearables while revealing a profound gap between clinical guidelines and real-world practice. Providers are forced to manage wearable-device-detected AF using evidence derived from traditional clinical settings or permanent implantable devices, resulting in fragmented and inconsistent care.

THE CHALLENGE OF THE LOW RISK, ASYMPTOMATIC PATIENT

A major gap identified the discrepancy between the population for whom current AF guidelines were written and those currently utilizing wearable technology. Landmark guidelines such as the 2023 ACC/AHA/ACCP/HRS update primarily address patients diagnosed through symptom-driven clinical encounters. In contrast, wearable users in studies like the Apple Heart and Fitbit Heart studies are frequently younger and carry lower CHA_2DS_2-VASc burden. Applying aggressive anticoagulation protocols to these individuals may shift the clinical balance from stroke prevention toward increased risk of clinically significant bleeding. The prognostic significance of brief, intermittent PPG-captured episodes remains unknown, raising the critical question of whether wearable-detected AF represents a distinct clinical entity requiring its own evidence-based intervention thresholds.[5,9,10]

ANTICOAGULATION EVIDENCE IS MODALITY AND POPULATION SPECIFIC

An important caveat for clinicians is that both the ACC/AHA/ACCP/HRS and ESC frameworks summarized above were built primarily on the trials of implanted device detected SCAF/AHRE, mainly ARTESiA and NOAH-AFNET 6 rather than on consumer wearable alerts.[29,30] ARTESiA randomized patients with device-detected SCAF to apixaban or aspirin and found that apixaban reduced stroke and systemic embolism, at the increased cost of major bleeding, providing the strongest evidentiary support for the ACC/AHA Class 2a/2b tiered approach.[29] NOAH-AFNET 6, in comparison, found that edoxaban did not significantly reduce a composite cardiovascular end point compared to placebo and increased bleeding, evidence that is more consistent with the ESC's decision to withhold a defined duration threshold and offer only a Class 2b recommendation in selected high-risk patients.[30] Neither trial enrolled patients whose AF was identified by a consumer PPG notification or a patient-triggered single-lead ECG; participants were instead identified through continuous monitoring by implanted devices capable of far more precise AF burden quantification than a brief wearable alert. Extrapolating either guideline's thresholds to wearable detected AF therefore warrants caution, particularly when the underlying signal is an unconfirmed

PPG notification rather than an interpretable ECG tracing. The recently published ALONE-AF trial—which showed that selected post-ablation patients with stroke risk factors could safely discontinue anticoagulation after a year free of AF recurrence—addresses a different clinical question (stopping anticoagulation after ablation rather than initiating it for screen-detected AF), but it reflects the same broader shift towards individualized, duration- and risk-based anticoagulation strategies that also inform decisions for wearable-detected AF.[31]

VARIABILITY IN DECISION MAKING AND SPECIALTY DISCREPANCIES

The substantial heterogeneity in physician responses illustrates a lack of professional consensus. The threshold gap, in which clinicians' requirements for anticoagulation range from 5 to 6 minutes to more than 24 hours of AF, suggests providers are operating in a gray zone of evidence. The increased likelihood of electrophysiologists to utilize digital-first confirmation methods compared to the more conservative referral patterns of PCPs indicates that specialty-specific comfort levels with digital health data are creating uneven levels of care. Without standardized pathways, management of a wearable alert becomes a product of clinician intuition rather than unified evidence.

HEALTHCARE UTILIZATION AND THE BURDEN OF DETECTION

The burden of detection has effectively shifted from the clinic to the patient, resulting in a surge of downstream healthcare utilization. With 36% of notified users in the Apple Heart Study undergoing secondary cardiac testing and 24% receiving cardioversions, resource consumption is significant. While early detection is seemingly beneficial, the high rate of follow-up testing and specialist referral may place undue strain on cardiovascular services, particularly if a large proportion of alerts represent low-risk atrial ectopy or transient, self-limiting episodes.[9]

PATIENT-REPORTED BURDEN OF FALSE AND UNCONFIRMED ALERTS

The consequences of shifting detection to the patient are not purely logistical. False or unconfirmed irregular rhythm notifications have been associated with measurable psychological burden. Users who received a smartwatch alert that was not subsequently corroborated on confirmatory testing reported decreased perceived physical well-being relative to users whose alerts were confirmed or who received no alert at all.[32] Given that a substantial minority of PPG notifications in the largest pragmatic studies were not confirmed as AF on follow-up ECG monitoring, this represents a non-trivial number of otherwise healthy individuals exposed to anxiety, unnecessary clinic visits, and low-value testing. Any future management pathway or guideline update should weigh this patient-level harm alongside the benefits of early detection rather than treating alert accuracy purely as a diagnostic performance metric.

PROPOSED CLINICAL MANAGEMENT PATH FOR WEARABLE-DETECTED ATRIAL FIBRILLATION

Building upon observed clinical management patterns and physician-reported preferences, we propose a conceptual clinical pathway for the evaluation of wearable-detected AF. This pathway, demonstrated in Figure 2, synthesizes observed practice and guideline principles but has not been prospectively validated and should be regarded as hypothesis-generating rather than a validated management algorithm. This framework integrates the high propensity for confirmatory testing seen across all surveyed specialties with the evidence-based risk stratification models utilized in large-scale interventional trials. Critically, entry into the pathway should distinguish an unconfirmed PPG notification, which requires confirmatory single-lead or 12-lead ECG evaluation before any risk stratification, from an interpretable ECG tracing already demonstrating AF, which can proceed more directly to CHA_2DS_2-VASc based risk stratification. By formalizing the transition from a digital alert to definitive management, incorporating symptomatic assessment, medical history, and CHA_2DS_2-VASc stroke risk evaluation, this pathway aims to bridge the current guideline-practice gap. The proposed model prioritizes shared decision-making to balance the potential benefits of early anticoagulation in high-risk patients against the risks of over-treating transient or low-burden episodes in younger asymptomatic populations.

IMPLICATIONS FOR FUTURE GUIDELINE DEVELOPMENT

The findings synthesized here suggest that future iterations of AF management guidelines may benefit from explicitly stratifying recommendations by detection modality rather than treating "device-detected" AF as a single category encompassing both implanted monitors and consumer wearables. A modality-specific framework would distinguish, at minimum, an unconfirmed PPG notification, an interpretable single-lead ECG tracing, and continuous ambulatory or implanted device monitoring, each carrying a different pretest probability of true AF and a different evidentiary base for anticoagulation. Standardized reporting of AF burden, total minutes or hours confirmed, rather than a binary "AF present/absent" label across future wearable studies would also allow more direct comparison with the duration-based

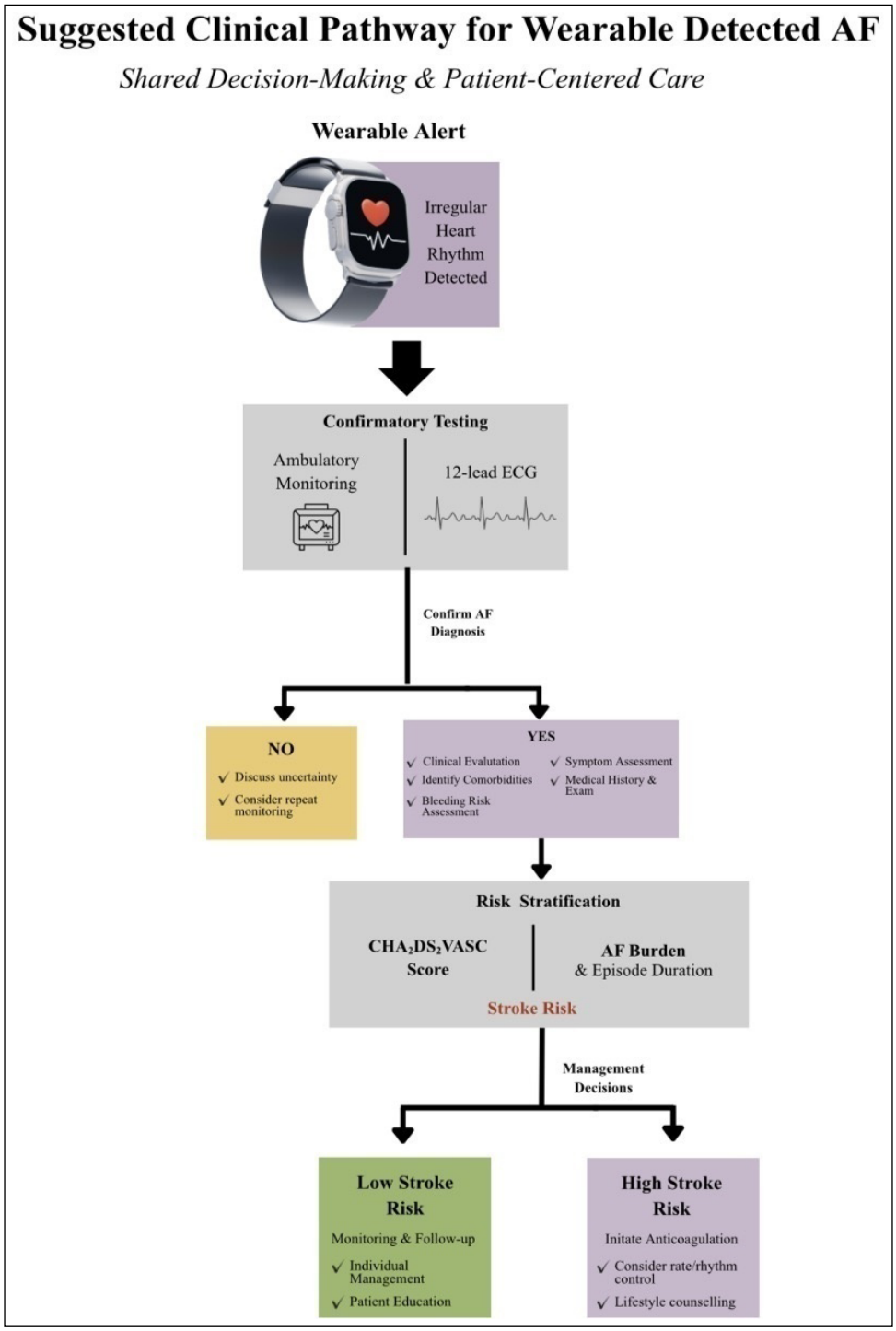


Figure 2 Proposed conceptual clinician pathway for the management of consumer wearable-detected atrial fibrillation, integrating symptomatic assessment, confirmatory diagnostic testing, CHA_2DS_2-VASc risk stratification, and shared decision-making for direct oral anticoagulation initiation. AF: atrial fibrillation; CHA_2DS_2-VASc: congestive heart failure, hypertension, age ≥75, diabetes, stroke/transient ischemic attack, vascular disease, age 65–74, sex category; DOAC: direct oral anticoagulation; ECG: electrocardiogram; PCP: primary care provider; PPG: photoplethysmography

thresholds already established for implanted devices. Until such modality-specific evidence is available, we believe the conceptual pathway proposed above applied within a shared-decision framework offers the most defensible interim approach.

FUTURE DIRECTIONS

Prospective longitudinal studies are urgently needed to move from device accuracy to clinical utility. The REGAL-AF trial represents a pivotal step by using AI-ECG risk scores to target Apple Watch monitoring toward patients most likely to have

actionable AF, aiming to prove that digital screening can lead to measurable reductions in ischemic stroke and mortality. The PATCH-AF trial is addressing the gray zone of arrhythmia burden, implementing yearly, 7-day continuous ECG patch monitoring in high-risk primary care patients to determine the prognostic significance of paroxysmal, low-burden AF. Beyond clinical trials, future research must address seamless integration of wearable data into electronic health records, health economic evaluations, and inclusive recruitment of socioeconomically diverse and high-risk elderly populations to ensure digital health advancements do not exacerbate existing health disparities.

LIMITATIONS

This review is limited by the inherent heterogeneity of included studies, ranging from large, pragmatic trials to subjective clinician surveys, and spanning multiple detection modalities (PPG notifications, patient triggered single-lead ECG, and continuously recorded ECG patches) that carry different diagnostic certainty and cannot be assumed equivalent. Definitions of "confirmed AF" and the denominators used to report outcomes such as DOAC initiation, secondary testing, and cardioversion varied across studies and were not always explicitly stated in the course literature, limiting direct comparison. Populations also differ by age, comorbidity burden, and baseline stroke risk, limiting generalizability to populations facing cost or literacy barriers to digital health technology. Selection bias exists due to keyword and article inclusion criteria, and findings reflect only studies identified in the specified electronic databases published in English. Many studies relied on participant self-reporting, and several (including the Apple Heart Study) faced substantial loss to follow-up, which may limit generalizability to all clinical settings.

CONCLUSION

This systematic review highlights that while consumer wearables have successfully expanded access to AF detection, clinical management remains fragmented and nonstandardized across detection modalities. Data reveal high rates of clinical engagement and anticoagulation initiation in interventional trial settings; however, clinician surveys reveal deep uncertainty regarding therapeutic thresholds for low-burden, screen-detected arrhythmia. As wearables move AF detection outside traditional clinical pathways, the development of unified, modality- and burden-specific guidelines is essential. Until such data are available, a shared decision-making model supported by the conceptual pathway proposed in this review may help to ensure digital health technology leads to improved patient outcomes without over-medicalizing low-risk populations.

KEY POINTS

- There is near-universal agreement (99.5%) that a wearable alert must be validated by physician-interpreted electrocardiography (ECG) or Holter monitor before a formal diagnosis is made.
- Despite diagnostic agreement, treatment thresholds vary drastically: 34% of clinicians require a 24-hour atrial fibrillation burden to treat, while 15% would initiate anticoagulation for as little as 5 to 6 minutes.
- Wearables are a powerful entry point into the healthcare system; between 57% and 83.5% of notified users seek medical follow-up, although outcomes are not interchangeable since direct oral anticoagulant initiation among confirmed cases ranged from 12% to 90% depending on population and denominator.
- To prevent over-treating low-risk users, a standardized framework is required that integrates CHA_2DS_2-VASc scores with detection modality-specific duration thresholds, particularly for the 6-minute to 24-hour gray zone that distinguishes photoplethysmography notifications from ECG-confirmed AF.

COMPETING INTERESTS

The authors have no competing interests to declare.

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