

Evaluating the use of the mobile electrocardiogram technology KardiaMobile™ in community settings: An online survey

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KardiaMobile™ ECG Devices

Abstract

Background: In response to issues identified by community healthcare professionals (HCPs), including difficulty in routinely recording electrocardiograms (ECGs) at the time of their assessments with the population of patients referred to as 'housebound', one National Health Service (NHS) Trust adopted the mobile ECG technology; KardiaMobile™, supported by the Academic Health and Science Network (AHSN), in 2017–2018. The use and uptake of this technology were evaluated and are reported in this paper.

Methods: A cross-sectional, mixed-methods online survey was conducted from August 2021 to October 2021. The respondents were a convenience sample of HCPs using KardiaMobile™ to detect atrial fibrillation (AF) with their patients; all were employed by one, predominantly rural NHS trust. Descriptive methods were used to analyse the quantitative data, whilst a reflexive approach to thematic analysis was chosen to analyse the qualitative data (Braun & Clarke, 2019, *Qualitative Research in Sport, Exercise and Health*, 11, 589).

Results: A total of 33 surveys were completed, with a response rate of 8.8%. All respondents recognised the potential value of KardiaMobile™ for their work. Nineteen respondents (57.6%) reported having a shared understanding of the purpose of KardiaMobile™. Nineteen respondents (57.6%) agreed sufficient training and resources are provided to enable staff to implement KardiaMobile™. Qualitative data analysis found four overarching themes, with six sub-themes.

Conclusion: KardiaMobile™ is a feasible means to detect AF in higher-risk patients, particularly those living remotely or classed as 'housebound'. Respondents in this survey indicated a desire for further training and input on the appropriate use of digital and mobile devices for AF care in a community setting. Incomplete integration of device-collected heart rhythm data into the patient electronic health record was identified as a barrier to greater adoption of digital health devices for community HCPs.

No Patient or Public Contribution: Not required as it is a service evaluation from the perspective of HCPs using KardiaMobile™ technology.

KEYWORDS

electrocardiogram, eHealth, KardiaMobile, mobile ECG

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1 | BACKGROUND

Technology is continually evolving, giving rise to new possibilities for prevention, care and treatment. The uptake of proven, affordable innovations in digital technology, including digitalising community services and deploying technology to support community staff, is specifically highlighted in the NHS Long Term Plan (NHS, 2019). The use of smartphones by healthcare professionals has improved clinical communication and access to information systems and clinical tools at the point of care, from anywhere, at any time. Nationally, campaigns to encourage greater use of technology exist and support the commitment to 'championing the use of technology and informatics to improve practice, address unwarranted variations and enhance outcomes' (NHS England, 2016; RCN, 2018). Despite the high-level support for healthcare technology in nursing, from organisations such as NHS England, the implementation, uptake and realisation of the expected benefits of health technology have not been as good across NHS community services when compared to acute hospital settings (NHS, 2019). To support and empower nurses working in community settings to use technology more effectively, the development of skills and training is needed (The Queens Nursing Institute, 2018). Technology, when implemented well, has the potential to significantly change the way in which care is delivered, but the experiences and attitudes of healthcare staff towards new technologies play an important role in how quickly they are accepted and how they are used in practice.

Atrial fibrillation (AF) is a common abnormal heart rhythm or arrhythmia, which usually results in an irregular fast pulse, although it can be asymptomatic. AF can increase the chance of blood clots forming, leading to increased risk of stroke (NICE, 2021). AF can be detected on an electrocardiogram (ECG); such devices are now available as mobile devices with smartphone technology. The digital transformation of services was advancing before the COVID-19 pandemic, however it has received more attention since 2020. Consequently, the opportunity for healthcare professionals (HCPs) using mobile ECG technology to detect AF in patients unable to easily physically access health services has arisen. This population of patients is unable to physically access services, such as General Practitioner (GP) practices, pharmacies and health centres, for routine examinations due to multiple, often complex, medical conditions rendering them 'housebound', requiring HCP assessments to take place at their home. However, there is minimal research evidence on the experiences of HCPs using mobile ECG technology in community and rural settings (Emmett et al., 2022).

There are numerous commercially available wearable and handheld mobile ECG devices directly marketed to consumers for AF monitoring and identification of unknown AF (Dzikowicz, 2024). KardiaMobile™ is one such example that has been introduced in clinical practice and is the only device that has Medical Technologies Guidance (MTG) published by the National Institute for Health and Care Excellence (NICE, 2022). It is available as a single-lead or a

6-lead ECG recorder and works with a compatible smart mobile device to run the KardiaMobile™ application. While taking a reading, the ECG recording is sent wirelessly to the mobile device where it can be viewed in the application. The ECG recording can then be made available to the HCP as soon as it is taken, rather than at the end of a specified monitoring period, as is the case with Holter monitoring. Clinical evidence shows significantly more people had AF detected using KardiaMobile™ compared with a Holter monitor (NICE, 2022). In response to this, and the growing demand for community HCPs to record ECGs at the time of their assessments in patients' homes, the authors' employer (a community NHS Trust in England) adopted the use of KardiaMobile™ by specialist community nursing teams as a service improvement initiative. This was supported by the regional Academic Health and Science Network (AHSN) in 2017–2018 as part of the national mobile ECG roll-out programme, and the 'Detect, Protect, Perfect' campaign (AHSN, 2018). The National Institute for Health and Care Excellence (NICE) has since produced Medical Technologies Guidance for the use of KardiaMobile™ (NICE, 2022), and the device is now recommended as an option for detecting AF in people with suspected paroxysmal AF who present with symptoms. In response to this improvement initiative, an online survey was used, as a service evaluation, to seek feedback on the use of this technology by HCPs and their perceptions of its future use amongst healthcare teams and services. It is these findings that are reported in this paper.

1.1 | Anticipated findings and their relevance to clinical practice

- To gain insight and understanding into the day-to-day use of mobile ECG technology within NHS community services and how, as technology continues to advance, HCPs may be supported to build upon the services they are able to deliver.
- To support further research on the use of mobile ECG technology for the detection of unknown AF and offer an original contribution to knowledge.

1.2 | Aim

To conduct an anonymous online survey to explore and evaluate the use of KardiaMobile™ ECG technology from the perspective of HCPs to gain insight into the experiences and factors that influence its uptake and usage in practice.

2 | METHODS

A cross-sectional mixed-methods survey entitled 'KardiaMobile™ Service Evaluation' was conducted from August 2021 to October 2021 (Document S1 in Appendix S1). A mixed-methods approach was chosen because it utilises the potential strengths of both

qualitative and quantitative methods, allowing exploration of diverse perspectives (Cresswell & Clark, 2017). This approach enabled exploration of the what and how KardiaMobile™ is being used, and, by including qualitative narrative data, we were able to gain insight into the experiences and factors that influence its uptake and usage in practice. The Checklist for Reporting Results of Internet E-Surveys (CHERRIES) (Eysenbach, 2004) was used to plan, undertake and report this survey (Document S2 in Appendix S1).

Prior to survey implementation, information from the local NHS Clinical Commissioning Group (CCG) was used to ascertain which services were using or had experience of using KardiaMobile™ technology in practice. Eligible respondents were community specialist nursing services, community matrons, community cardiac nurses, community specialist therapy teams (falls service), general practitioners (GPs) and healthcare assistants (HCAs). The survey was pilot tested at one of the services team meetings, with approximately 10 staff currently using the KardiaMobile™ technology. No questions were modified.

The community staff were provided with an information sheet (Document S3 in Appendix S1) and sent a link to an open online survey using the authors' institution approved and licenced survey site; 'JISC'. This service operates in the UK, is governed by the UK law, is General Data Protection Regulation (GDPR) compliant and meets the ISO/IEC 270001 information security management standard. Implied consent was provided by respondents by completion and submission of the survey; separate written or verbal consent was not obtained. Research Ethics Committee approval was sought and granted by the Faculty of Health's Research Ethics Committee at the University of Plymouth.

The survey consisted predominantly of 6- and 7-point Likert scale closed questions and was used to ascertain information about the existing use of KardiaMobile™ from the perspective of the HCP. In addition to the ordinal scale, the survey included optional free text to allow respondents to elaborate if choosing 'other' as their answer. At the end of the survey, they were asked if there was anything else they would like to add about their experience of using KardiaMobile™, this was optional while all other questions were mandatory. The survey included questions to ascertain respondents' views, enthusiasm and potential roles in the future use of KardiaMobile™, in addition to any barriers and training-related feedback. The survey information, including the respondent information sheet and link, was disseminated by the local NHS CCG and NHS Trust on their staff bulletins, newsletters, intranet and social media platform Twitter account from August 2021, with a reminder noted in the CCG meeting minutes and posted on social media 1 month after opening to improve response rate.

2.1 | Analysis

Descriptive analysis of the quantitative data was undertaken through JISC (Joint Information Systems Committee), following which the data were exported into an Excel spreadsheet for further



FIGURE 1 Six-phase analytical process (Braun & Clarke, 2021).

exploration. The qualitative data were uploaded to the authors' institution approved and licenced software; NVivo12 (Jackson & Bazeley, 2019; NVivo12, 2018) and analysed using the six-phase analytical process (Figure 1) for conducting thematic analysis (Braun & Clarke, 2019, 2021).

This enabled an element of theoretical flexibility in the analysis, allowing us to move back and forth through the phases as necessary, and as such, served as a useful guideline, rather than strict rules.

Initial codes were generated and developed into themes to capture the main ideas, underpinned by the pre-existing knowledge of the authors' use of mobile ECG technology in the community. The themes were then reviewed, finalised and named. Finally, representative quotes were organised under each of these themes to accurately depict the voice of participants and ensure the concepts remain close to their own words or terms.

3 | RESULTS

A total of 33 healthcare professionals (HCPs) completed the online survey, including the optional question requesting for demographic information, resulting in a response rate of 8.8%. Of the respondents, 26 (78.8%) were nurses, 5 (15.2%) were medical personnel, 1 (3%) was an allied health professional and 1 (3%) was from the management (Table 1).

The respondents' years of experience are shown in Table 2 and range from 1 to 2 years (15.2%) to more than 15 years (18.2%).

Table 3 demonstrates that 97% (32) of respondents could see the potential value of KardiaMobile™ in their work.

The following results relate to survey questions 4, 6, 7 and 8 and are depicted in Table 4.

Ninety-seven per cent (32) of respondents strongly agreed or agreed they can easily integrate KardiaMobile™ into their existing work. However, time for reviewing ECGs was not always given:

There is no time allocation for reviewing the potential number of ECG's generated.

Nineteen respondents (57.6%) either strongly agreed or agreed staff have a shared understanding of the purpose of KardiaMobile™, whilst 14 (42.4%) either disagreed or were unsure. Twenty-two respondents (66.7%) either strongly agreed or agreed that there are key people who champion KardiaMobile™ in the community, although who these people were was unclear to some (11 (33.3%) either disagreed, neither disagreed nor agreed, or did not know). There were mixed views about the adequacy of training, with 19 respondents (57.6%) either strongly agreeing or agreeing sufficient training and resources are provided to enable staff to implement KardiaMobile™, whilst 13 (39.4%) either disagreed or were unsure and 1 person disagreed strongly (3%).

Twenty-three respondents (69.7%) were confident or very confident in their colleagues being open to working in new ways using KardiaMobile™, whilst 3 (9.1%) were somewhat confident, 1 (3%) was not confident at all and 6 (18.2%) did not know (Table 5).

Twenty-six respondents (78.8%) were confident or very confident in their colleague's ability to use KardiaMobile™, whilst 2 (6.1%) were somewhat confident and 5 (15.2%) did not know (Table 6).

The following results relate to the final survey questions 11, 12 and 13, which report on the integration and familiarity of KardiaMobile™ to the healthcare professional now and in the future.

TABLE 1 Demographics of participants.

Participants' job category	Distribution
Nursing	26 (78.8%)
Medical	5 (15.2%)
Allied Health Professional	1 (3%)
Management	1 (3%)

When using KardiaMobile™ with patients, five HCPs (15.1%) said it still feels quite new, 7 (21.2%) said it felt quite familiar, 19 (57.6%) said it felt completely familiar and 2 (6.1%) were unsure.

Twenty-four respondents (73%) agreed KardiaMobile™ was a completely normal part of their work, whilst 8 (24%) felt it was only somewhat and one person (3%) felt it was not at all a normal part of their work. When asked if they felt KardiaMobile™ will become a normal part of their work, 24 respondents (73%) answered completely, 8 (24%) answered 'somewhat' and 1 (3%) answered 'not at all'.

3.1 | Qualitative results

Supported by extracts from the qualitative data set, Table 7 illustrates the coding and author generated themes and sub-themes.

The free text data analysis generated the following codes and themes.

We assembled a mind map within NVivo12 (NVivo12, 2018) (Figure 2) to allow visual representation of the codes relative to their respective themes and sub-themes (Braun & Clarke, 2020).

The theme 'information technology (IT)' was definable with coded data from three narratives relating to communication within internal/external IT systems. This also relates to logistical issues across remote areas regarding the internet connectivity required to upload data collected by the device. Staff expectations versus limitations of the technology in a community setting were also interpreted by the authors and are underpinned by pre-existing knowledge and experience of this as a commonality. The theme 'staff experience' was generated from four narratives relating to confidence and competencies with new technology and patient suitability. Both these themes were generated from the initial code of 'training needs'. The authors emphasised staff training needs as an important factor in promoting appropriate, practical, targeted use of the technology in

TABLE 2 Respondents' years of experience.

Years of experience	Respondents
Less than 1 year	0
1–2 years	5 (15.2%)
3–5 years	6 (18.2%)
6–10 years	6 (18.2%)
11–15 years	10 (30.3%)
More than 15 years	6 (18.2%)

TABLE 3 Survey Question 5: I can see the potential value of KardiaMobile™ for my work.

Question 5	Response
Strongly agree	23 (69.7%)
Agree	9 (27.3%)

TABLE 4 Answers to survey questions 4, 6, 7 and 8.

	Question 4	Question 6	Question 7	Question 8
Strongly agree	23	14	12	12
Agree	9	5	10	7
Neither agree nor disagree	0	8	6	8
Disagree	1	6	4	5
Strongly disagree	0	0	0	1
Don't know	0	0	1	0

TABLE 5 Survey Question 9: Confidence in colleague's ability being open to working in new ways using KardiaMobile™.

Question 9	Response
Very confident	13 (39.4%)
Confident	10 (30.3%)
Don't know	6 (18.2%)
Somewhat confident	3 (9.1%)
Not confident at all	1 (3%)

community settings. Under the code 'resources', the themes 'staffing' and 'funding' were generated from a total of six narratives. Both themes related to, and closely linked with, the requirement for ongoing investment in clinician time and technology suitable for use in community settings. Under the code 'usage', five narratives were conceptualised as two separate sub-themes reflecting barriers to the use of mobile ECG technology, we quantified these barriers into 'institutional' and 'individual'. The individual barriers related to HCPs practically using the technology with suitable patients. In addition to this, under the code 'usage', eight narratives relating to using the technology within the setting of 'community' were clearly definable. The authors' experience supported the importance of increasing access to diagnostics for the 'housebound population'. Taking account of the complexities, challenges and availability of current service provision for patients living remotely and community staff travelling considerable distances to access them (The Queens Nursing Institute, 2018).

The authors conducted a recursive review of the themes in relation to the coded data, the entire data set and the research objectives. As a result of this, the authors concluded the creation of an additional code was necessary to present the perspectives of HCPs using KardiaMobile™ with patients. This code was named 'quotes' and was generated from a total of 17 narratives relating to KardiaMobile™ use in practice, all of which were positive, demonstrated an acceptability and potential for the integration of technology such as this within a community setting (Table 8).

The authors concluded the codes formed a coherent pattern, the themes were then reviewed in relation to the data set and assessed for logical interpretation of the data in relation to the research aim. We concluded the codes, themes and sub-themes to be defined, appropriate and logically inform the interpretation of the data set.

TABLE 6 Survey Question 10: Confidence in colleagues' ability to use KardiaMobile™.

Question 10	Response
Very confident	16 (48.5%)
Confident	10 (30.3%)
Don't know	5 (15.2%)
Somewhat confident	2 (6.1%)
Not confident at all	0

4 | DISCUSSION

The use of, and investment into, digital devices has been catalysed by the COVID-19 pandemic (Ding et al., 2020). A joint statement from the Heart Rhythm Society (HRS), the American College of Cardiology (ACC) and the American Heart Association (AHA) emphasised the importance of converting to telemedicine visits for patients with non-urgent clinical needs, and further recommends 'obtaining ECG tracings using digital wearables where available' (Lakkireddy et al., 2020). This is significant advancement towards recognition of the potential of digital technologies in streamlining heart rhythm care and there have already been efforts to adopt and integrate these technologies to facilitate AF screening (Ding et al., 2020). However, more work is needed to optimise and integrate such technologies, and the experiences of HCPs are central and paramount to their successful uptake and sustainability.

In this survey, we evaluated the use of KardiaMobile™ ECG technology from the perspective of HCPs working in one NHS Community Trust. We collected data from 33 voluntary HCPs, the majority of whom were nurses and GPs. We identified that all participants found the KardiaMobile™ ECG technology to be quick, simple and easy to use; furthermore, the authors noted a perceived sense of satisfaction and enjoyment at being able to share new, innovative technology with colleagues and patients. There were clearly training needs identified with some staff indicating that they lacked some understanding of the purpose of KardiaMobile™ and feeling unprepared for its use. The participants identified the importance of 'change champions'; the use of change/leadership models to support the integration (with current workflows), transformation and evaluation of mobile ECG technology was highlighted in a systematic review (Emmett et al., 2022).

TABLE 7 Coding and generation of themes and sub-themes.

Initial codes	Example participant quotes	Author notes	Themes	Sub-themes
Training needs	'The difficulty I have found is with GP's not having the confidence when prescribing anticoagulants in the community.' 'The reporting of abnormal results within the appropriate "shared folder" is not embedded within my practice' 'Many clients have rheumatoid digits/ shakes and can't make good contact; often poor trace – would be good to get alternatives /tips for this' 'Further consideration is planned whilst reviewing competencies in our team'	Communication with prescribing HCPs Confidence in newer technology Communication within internal and external IT systems Practicalities and suitability for all patients	Information Technology (IT) and Staff Experience	
Resources	'New members of staff often don't get issued with Kardia' 'as a nursing team of 8 only have around 4 devices and are awaiting monies to purchase more or devices not used by other services to be donated to us' 'I ask patients to purchase the devices themselves as we have none' 'we did consider purchasing some but we do not have time to analyse all the potential recordings'	Ongoing investment in technology suitable for use in community settings Inequality of use, access to mobile ECGs in community Clinician time vs. patient benefit	Staffing and Funding	
Usage	'Its a fantastic tool to have immediate access within a patients home' 'we have identified AF with many of our patients in the community'. 'Not always easy to get good / complete readings from device'. 'We do sometimes have difficulty with the devices in remote areas due to internet coverage'	Increasing access to diagnostics for the 'housebound population' The availability of services for patients living remotely Challenges using mobile technology in community settings	Community setting and Barriers to use	Institutional and Individual

The importance of an initial familiarisation period for the HCPs to become proficient at using the KardiaMobile™ Application on their smartphone and the KardiaMobile device itself is supported in the literature. Staff training procedures and 'onsite assistance' helped HCPs overcome these issues in other similar studies (Macniven et al., 2019). Such periods need to be flexible in duration since the length of familiarisation period and the need for further training and support tend to be longer for those staff not comfortable with smartphone technology (Lowres et al., 2015).

Patient suitability emerged within the qualitative data, and is widely discussed in the literature (NICE, 2021, 2022; Schnabel et al., 2022), specifically that KardiaMobile™ is appropriate to be used as an option for detecting AF in people with suspected AF and those who are symptomatic. Therefore, appropriate patient selection may increase diagnostic relevance and yield (Ding et al., 2020; Schnabel et al., 2022).

These survey findings indicate that for this Community Trust, the use of KardiaMobile™ ECG technology for the detection of AF within community settings is both feasible and acceptable, despite barriers including lack of time to interpret the ECGs, logistical and technical

issues such as internet connectivity. However, many of these issues could be overcome to some extent in the future with upgraded smartphones/technology and enhanced broadband services. The extra time required for ECG data interpretation and the potential need for additional confirmatory testing supports the findings from other studies (Matthew & Chambers, 2021; Orchard et al., 2016; Schnabel et al., 2022). The challenge of balancing priorities and managing workflow is a widely reported barrier (Lowres et al., 2015); however, further research should be considered to address these barriers in the uptake and utility of mobile ECG technology.

Both the quantitative and qualitative data demonstrate the potential value of KardiaMobile™ ECG technology for patients, its integration into existing healthcare practice within community settings is possible with training and support. This is particularly valuable in rural and remote locations where disparities in health service provision exist and access to diagnostics is more challenging (NHS, 2019; Public Health England, 2019, 2021). The qualitative data highlight the usefulness of the device in the detection of AF and its acceptability in routine practice as part of HCP patient

FIGURE 2 Mind map.

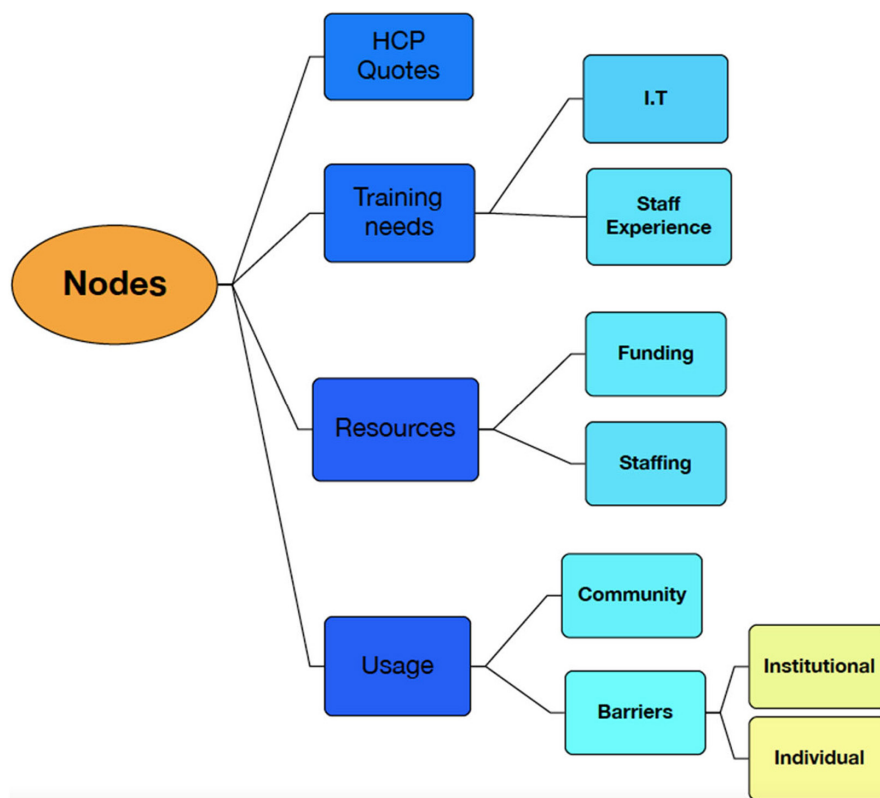


TABLE 8 Additional code with example respondent quotes.

Additional code	Example participant quotes	Author notes
Quotes	'It gives patients reassurance'. 'a helpful tool' 'I would feel a complete loss if this was removed from my clinical tool kit' 'Quick, easy and simple to use'.	A positive addition to clinicians' assessments. Available to clinicians in the community

assessments, specifically in providing an easy-to-use resource to assist in diagnosing AF. These are positive enablers to achieving greater access to, and update of, preventive services within primary care, known to be linked with better health outcomes (NHS, 2019; NHS Digital, 2019; Public Health England, 2019, 2021).

4.1 | Strengths and limitations

A strength of this study was the inclusion of qualitative narrative data from HCPs using KardiaMobile™ ECG technology in practice. The free text option within the survey provided opportunities for the participants to share their experiences of using KardiaMobile™. This added some depth and enriched the quantitative data providing a limited understanding of how this population of HCPs felt in regard to using the mobile ECG technology (Shorten & Smith, 2017).

There were only 33 respondents to this online survey, which inevitably limit the transferability of the results. It is not possible to say that these findings are representative of all HCPs using

KardiaMobile™ across the UK and internationally. Despite this, the findings provide useful insight into the uptake of mobile technology. Furthermore, the survey was launched during the COVID-19 pandemic, which may have adversely affected the response rate. This appears to be the first mixed-methods survey to evaluate the use of KardiaMobile™ ECG technology in practice within a community setting, and it is an area requiring further focus and research on a wider scale.

5 | CONCLUSION

Overall, KardiaMobile™ ECG technology appears to be well accepted amongst healthcare professionals working in a community setting and is a feasible means to detect AF in higher-risk patients, particularly in those living remotely or are classed as 'housebound' due to complex and/or multiple disabling health conditions. Respondents in this survey generally hold positive attitudes to the use of KardiaMobile™ ECG technology for AF detection but indicate a desire for further training and input on the appropriate use of digital

and mobile devices for AF care in a community setting. Furthermore, incomplete integration of device-collected heart rhythm data into the patient electronic health record was identified as a barrier to greater adoption of digital health devices for community HCPs.

Due to the increased usage of mobile technologies, driven in part by the COVID-19 pandemic, more research is needed to explore the impact of integrating digital technologies into community services, including patient-reported and clinical outcomes and the quality of life and stroke. Further research on the effectiveness and cost-effectiveness of health care and technology-enabled interventions such as mobile ECG to reduce inequalities in rural areas would be beneficial. In addition, ensuring digital inclusion is central to the design of future services. The widespread penetration of consumer-targeted devices capable of AF detection will likely continue to necessitate healthcare professionals adapting their practices to accommodate novel, patient-driven technologies such as mobile ECG technology for AF detection.

The results of this survey reveal a positive impact on the detection of AF using KardiaMobile™ technology within one NHS Community Trust and HCPs value having access to this for their patients. These findings are in keeping with those of other studies reporting a similar value in utilising KardiaMobile™ for the detection of AF (ESC, 2020; Jones et al., 2020; NICE, 2021, 2022). Thus, for this organisation and the population it serves, mobile ECG technology such as KardiaMobile™ can be used in real-life practice and, with appropriate staff support and training, should be considered as an option to address some of the challenges in detecting AF in the housebound population.

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CONFLICT OF INTEREST STATEMENT

All authors declare no conflict of interest in publishing this survey.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Research Ethics approval was sought and granted by the Faculty of Health's Research Ethics Committee at The University of Plymouth Faculty (Reference: 2370).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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