University of Essex

Evaluation of Remote Monitoring Pilot to Identify Atrial Fibrillation

Report on pilot in West Suffolk

May 2023

Report written by:
Prof Mariachiara di Cesare, Institute of Public Health & Wellbeing
Dr Nestor Asiamah, School of Health and Social Care
Vanessa Baxter, School of Health and Social Care

Contents

Headlines

The University of Essex was commissioned by Eastern AHSN to evaluate the Atrial Fibrillation (AF) remote monitoring pilot in West Suffolk. This used FibriCheck - a smartphone app to monitor heart rhythm and to track symptoms - and the Zio XT biosensor patch - a small and lightweight, easy-to-wear ECG that records and measures the heart's electrical activity.

An invite to take part in the pilot was sent to 10,430 people via text message and 1,298 downloaded the FibriCheck app. Of these, 36 were sent a Zio XT biosensor patch (i.e. went through the complete pathway).

Digital and remote monitoring appears to be an acceptable approach to a significant proportion of patients at higher risk of AF although engagement reduces with age, particularly from the age of 80 and above. Alternatives for older patients, and those who do not or cannot access a digital approach, should be in place.

How acceptable is the remote AF detection pathway to patients?

- The remote monitoring approach was acceptable to a significant proportion of those invited (the majority of whom are over 65), although not everyone can or wants to use a digital/virtual approach, preferring in-person.
- The proportion of those under 60 who engaged (21%) was significantly higher than the total cohort whereas the proportion of those over 81 who engaged was significantly lower (5%). Engagement decreased as patients' ages increased.
- Participants going through the complete pathway perceived the pilot as a success, with four in the focus groups saying that otherwise they would not have been diagnosed with a heart condition.
- Over half of those surveyed who did not reply to the text invite felt that it is a good idea and would like to sign up now for the opportunity.
- 92% (n=352) of those using the FibriCheck app said it was easy to use to monitor their heart rhythm and were satisfied overall with using the app.
- All but one of those who had gone through the complete pathway were satisfied overall with using the Zio XT patch.
- Patients were fairly equally divided in their views about having virtual consultations with the nurse or cardiologist: some were happy to do this (although FaceTime was suggested as an alternative) and some would have preferred this to be in-person.

What impact has the pilot had on the identification of AF?

- As a population health initiative, the pilot reached and raised the awareness of AF for 10,430 at risk patients, of whom 12.4% were motivated to take up the offer texted to them, which the Public Health consultant felt was "phenomenal" for this kind of cold contacting.
- 0.77% (10 out of 1,298[1]) of those who engaged with the pilot were diagnosed with AF.
- Two patients out of the 10 identified as having AF had no noticeable symptoms so would not have been identified via the traditional routes.

[1] Data analysed by the University was supplied at individual patient level and is slightly different to the FibriCheck data (1,417 people downloading the app) which is at an aggregate level.

How acceptable is the remote AF detection pathway to healthcare professionals?

- Professionals involved in the delivery of the pilot felt it demonstrated that the remote monitoring approach was acceptable to an older population, as the response rate was very good and that there is a massive potential to use this kind of digital approach with an elderly population.

What impact did the pilot have on patient understanding and awareness of AF?

- Half (n=216) of survey respondents did not know much or anything about AF prior to being contacted. Knowledge about AF improved for just under half of those who read the information sent out about AF and the heart rhythm checks.

Methodology

Patient feedback was received via three online surveys with: 17 responses from those who went through the complete pathway; 438 responses from those who had downloaded the FibriCheck app but had normal readings and required no further follow up; and 532 responses from those who had not responded to the text invite to take part in the pilot. Additionally, two focus groups were held with patients who had gone through the complete pathway and virtual interviews were conducted with the 3 key staff at West Suffolk Foundation Trust who were involved in running the pilot.

Quantitative data on people who engaged with the pilot and their outcomes were analysed including sub-analyses by patient characteristics (i.e. age, gender, ethnicity, index of multiple deprivation, and risk score).

Key recommendations

- Alternative approaches for older patients, and those who do not or cannot access a digital approach, should be in place.

- It would be beneficial to run the pilot again so that, with greater awareness of it, people who did not respond to or declined the text invite might now accept the offer.

- Improvements to patient identification and communications should continue to be made, as an iterative process throughout the future rollout of the remote monitoring pathway. This should include: a communications strategy for healthcare staff and the wider population to reassure that it is a legitimate health campaign rather than a scam; the provision of information about each step of the process and what to expect; plus support for those having difficulty in using the digital approach.

- Further analysis is needed to understand why 36 patients were flagged as higher risk through a red report by FibriCheck and sent a Zio XT patch but only 10 of these were diagnosed with AF.

Background

Atrial Fibrillation (AF) is a chronic condition affecting around one million people in the UK and involves a significantly increased risk of stroke, with AF-related strokes more likely to be fatal or cause severe disability. Appropriate anticoagulant management of AF in all eligible patients could avert an estimated 4,551 strokes each year. This translates to £97 million savings in NHS and social care costs or £259 million savings in societal costs in the first year (Patel et al., 2020).

The mean cost of new-onset stroke is £45,409 in the first year after stroke and £24,778 in subsequent years. Of these costs, the mean annual cost per person from an NHS and Personal Social Services (PSS) perspective in the first year post-stroke is £18,081 (£13,269 attributable to the NHS and £4,812 to PSS). Annual NHS and PSS costs for subsequent years total £7,759, but a greater portion becomes attributable to PSS rather than NHS care (£5,544 versus £2,215) (Patel et al., 2020).

The NHS Long Term Plan identifies cardiovascular disease (CVD) as one of its priority disease areas, noting that it is the single biggest area where the NHS can save lives over the next 10 years. Specifically, the national AF target ambitions are:

- **Detection**: 85% of the expected number of people with AF are diagnosed by 2029.
- **Treatment**: 90% of patients with AF who are known to be at higher risk of a stroke to be adequately anticoagulated by 2029.

A collaborative partnership between Ipswich and East Suffolk CCG[2], West Suffolk CCG[1] West Suffolk Foundation Trust (WSFT), East Suffolk and North Essex Foundation Trust (ESNEFT), and Eastern AHSN (Academic Health Science Network) was formed to undertake a pilot project to identify patients at higher risk of AF and support them with a remote monitoring pathway in secondary care (at home heart rhythm checks via an app called FibriCheck). FibriCheck is a smartphone and smartwatch app to monitor heart rate, heart rhythm and to track symptoms. Zio XT is a biosensor patch that is a small, lightweight, easy-to-wear ECG, that records and measures the heart's electrical activity. FibriCheck has been previously used in a primary care and secondary care setting, for both detection and follow-up of undiagnosed and diagnosed AF patients.

The pilot's primary aim was to assess whether a completely virtual and digital remote heart rhythm monitoring pathway was acceptable and feasible for people identified as being at higher risk of AF in a secondary care setting, whilst providing a suitable pathway for further home monitoring to support diagnosis and treatment intervention without adding additional pressure to primary care services. The pilot also aimed to understand potential demographic factors associated with using digital home-monitoring equipment and the possible relationship between demographic factors and populations at higher risk of AF (age, gender, ethnicity etc.)

Pulling from WSFT population health management database, the pathway identified patients at higher risk of AF, providing access to technologies to enable remote heart rhythm monitoring and providing an effective therapy to manage those with detected AF.

[2] Both CCGs are now part of the Suffolk & North East Essex Integrated Care System

It was piloted for six months, initially aiming to engage up to 750 patients. The participants for this evaluation were individuals who had been identified as being at higher risk of AF, using the CHA2DSC-VSc scoring that includes factors such as age, blood pressure and underlying heart disease.

The University of Essex was commissioned by Eastern AHSN to provide an independent evaluation of the pilot. The key evaluation questions were:

- How acceptable is the remote AF detection pathway to a targeted, at higher risk cohort of patients?
- What impact has the remote AF detection pathway had on the identification of AF and the estimated impact on AF related strokes?
- How acceptable is the remote AF detection pathway to healthcare professionals using the pathway, including identifying any time or process efficiencies? This would include administrative teams, Public Health teams, nurses, cardiologist and clinic leads.
- What impact does the pilot have on patient understanding and awareness of AF?

Technology used in pilot

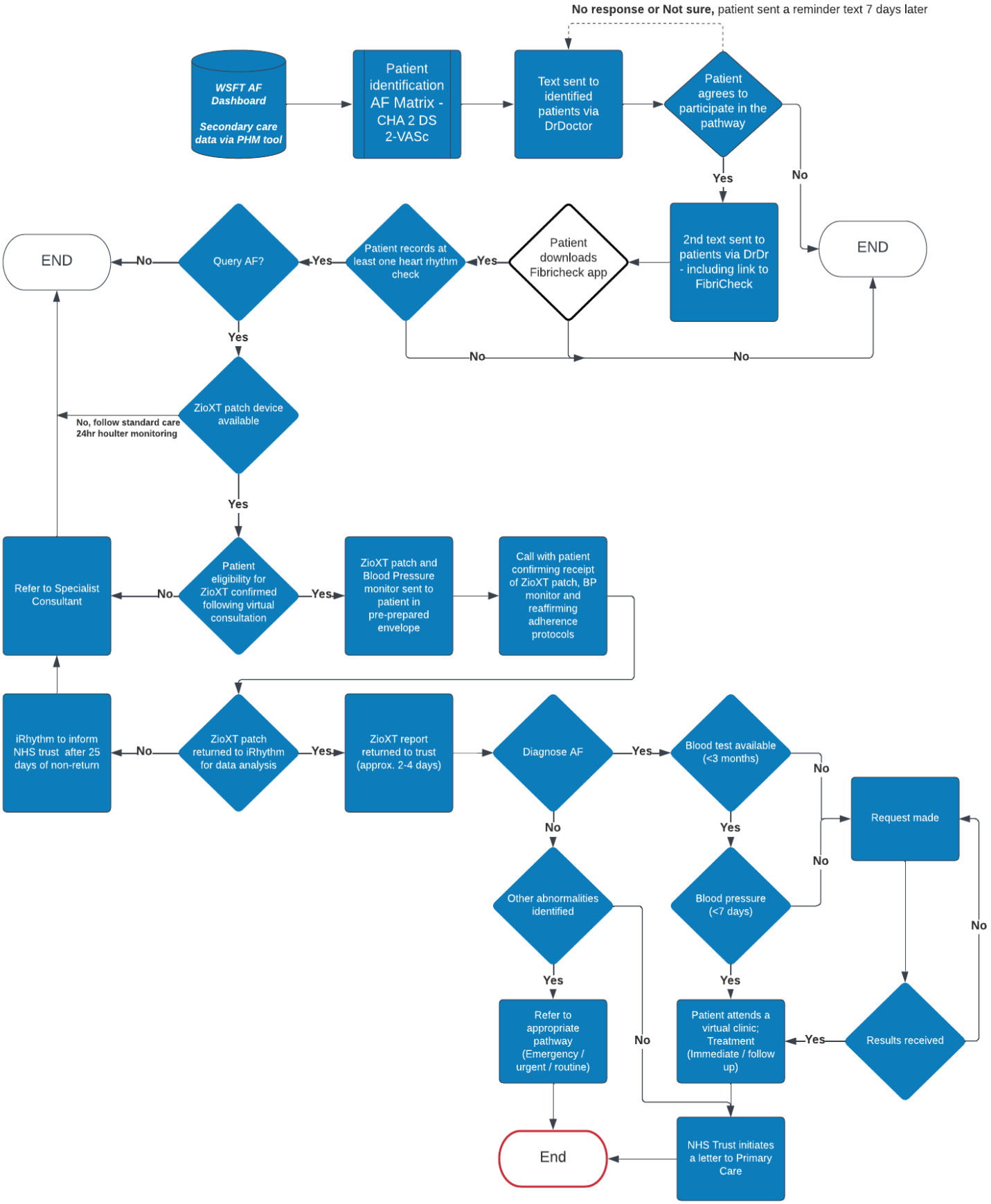
FibriCheck is certified as a medical device in Europe, UK, US and Australia, with proven clinical equivalence to single lead electrocardiogram (ECG) like AliveCor for the detection and monitoring of cardiac arrhythmias, including AF. FibriCheck is both a clinical decision platform and is a smartphone and smartwatch app[3] to monitor heart rate, heart rhythm and to track symptoms. Patients were invited via text message to download FibriCheck onto a smartphone, following download and activation of the application, heart rhythm is measured by placing a finger over the camera on the smartphone for one minute, which enables access to immediate and actionable results.

Patient monitoring data is available in real-time within the FibriCheck provider dashboard. Wherein symptom correlated biometric data is analysed and reviewed by medical professionals. Resulting diagnostic insights are visualised and used to inform evidence-based decision making for the next steps in care. Upon completion of the monitoring period, results are automatically consolidated, summarised into a report and made available to both patients and providers. With over 96% accuracy in the detection of AF, FibriCheck is used by over 350,000 people and is prescribed by more than 1,700 physicians.

Zio XT is recommended via NICE medical technologies guidance [MTG52] as an option for people with suspected cardiac arrhythmias who would benefit from ambulatory ECG monitoring for longer than 24 hours. The biosensor patch is a small, lightweight, easy-to-wear ECG, that records and measures the heart's electrical activity. It is worn constantly for up to 14 days and can be fitted by a patient at home, discreetly underneath their clothes. The monitor is water resistant and can continue to be worn during daily activities such as showering and moderate exercise. After use, the patient removes the patch and sends it via freepost for analysis. The ECG recordings are then analysed using an AI-developed algorithm, overseen by the iRhythms certified Cardiac Physiologists. A full report is then supplied to the NHS clinician for final analysis and interpretation within one to four days.

[3] The smartwatch option was not used for this pilot

Pathway


No response or Not sure, patient sent a reminder text 7 days later
WSFT AF Dashboard
Secondary care data via PHM tool
Patient identification AF Matrix - CHA 2 DS 2-VASc
Text sent to identified patients via DrDoctor
Patient agrees to participate in the pathway
Yes
No
END
2nd text sent to patients via DrDr - including link to FibriCheck
Patient downloads Fibricheck app
Patient records at least one heart rhythm check
Query AF?
END
No
Yes
No
No
Yes
ZioXT patch device available
No, follow standard care 24hr houlter monitoring
Yes
Refer to Specialist Consultant
Patient eligibility for ZioXT confirmed following virtual consultation
No
Yes
ZioXT patch and Blood Pressure monitor sent to patient in pre-prepared envelope
Call with patient confirming receipt of ZioXT patch, BP monitor and reaffirming adherence protocols
iRhythm to inform NHS trust after 25 days of non-return
No
ZioXT patch returned to iRhythm for data analysis
Yes
ZioXT report returned to trust (approx. 2-4 days)
Diagnose AF
Yes
Blood test available (<3 months)
No
Request made
No
Yes
No
Other abnormalities identified
Blood pressure (<7 days)
No
Yes
Yes
Refer to appropriate pathway (Emergency / urgent / routine)
Patient attends a virtual clinic; Treatment (Immediate / follow up)
Yes
Results received
No
No
End
NHS Trust initiates a letter to Primary Care

Evaluation methodology

Quantitative data analysis

The specific objectives of this statistical analysis were to assess:

1. The proportions of individuals diagnosed with AF.
2. The proportion of individuals who must be diagnosed to meet Public Health England's target of 85%[4].
3. Any differences in AF diagnosis among groups of patients (i.e., age, gender, ethnicity, deprivation and risk score).
4. Any differences in engagement among groups of patients (i.e., age, gender, ethnicity, deprivation and risk score)

This analysis was performed with SPSS (Statistical Package for the Social Science) version 28. The data were analysed in three phases. In the first phase, the data were summarised by estimating the proportions of individuals who engaged and were diagnosed. To set a basis for the second phase, descriptive statistics associated with the patient characteristics (i.e., age, gender, ethnicity, index of multiple deprivation, and risk score) were computed. Risk score and Index of Multiple Deprivation (IMD) were split into categorical variables with two groups (i.e., group 1 – 0-5; group 2 – 6 or higher). Gender had two categories (i.e., male – 1; female – 2), whereas age (i.e., Under 60; 60-65; 66-70; 71-75; 76-80; 81-85; 86-90, and above 90) and ethnicity (i.e., 1 – British White; 2 – Other White, and 3 – Asian/Africa and others) were in multiple groups.

In the second phase, the number of individuals to be diagnosed with AF to meet the national target for West Suffolk of 85% was estimated based on the number of AF diagnoses. Finally, the number of individuals who must engage in a similar pilot for the above target to be met was estimated using the ratio of the number of individuals currently diagnosed to the number of individuals who engaged.

In the third phase, differences in engagement and diagnoses across the patient characteristics were assessed with the chi-square goodness of fit test, which is used to assess differences between frequencies of two or more groups (Shih & Jay, 2017). Before using this tool, each group of the patient characteristics was coded into a dummy-type variable, allowing for a comparison of each category between those who engaged (named "engaged") and those who did not engage (named "not engaged"). The statistical significance of the results was detected at a minimum of $p<0.05$.

NB: FibriCheck data shows 1,417 people downloaded the app, but this number is only available at an aggregate level whereas the data supplied by WSFT for analysis by the University is at individual patient level and shows that 1,298 people downloaded the app.

[4] As presented in the AF Data Tool, https://aftoolkit.co.uk/af-data/af-data-tool/ - results for the latest year of data, 2019/20. This data for W Suffolk shows 1,649 people potentially undiagnosed with AF, which is 5% below the Public Health England and NHS England ten year cardiovascular disease ambitions of 85% detection for 2019/20 and 1.8% below the national average of 81.8. In addition, 414 people with AF need to be diagnosed to reach the 85% detection target.

Feedback from patients

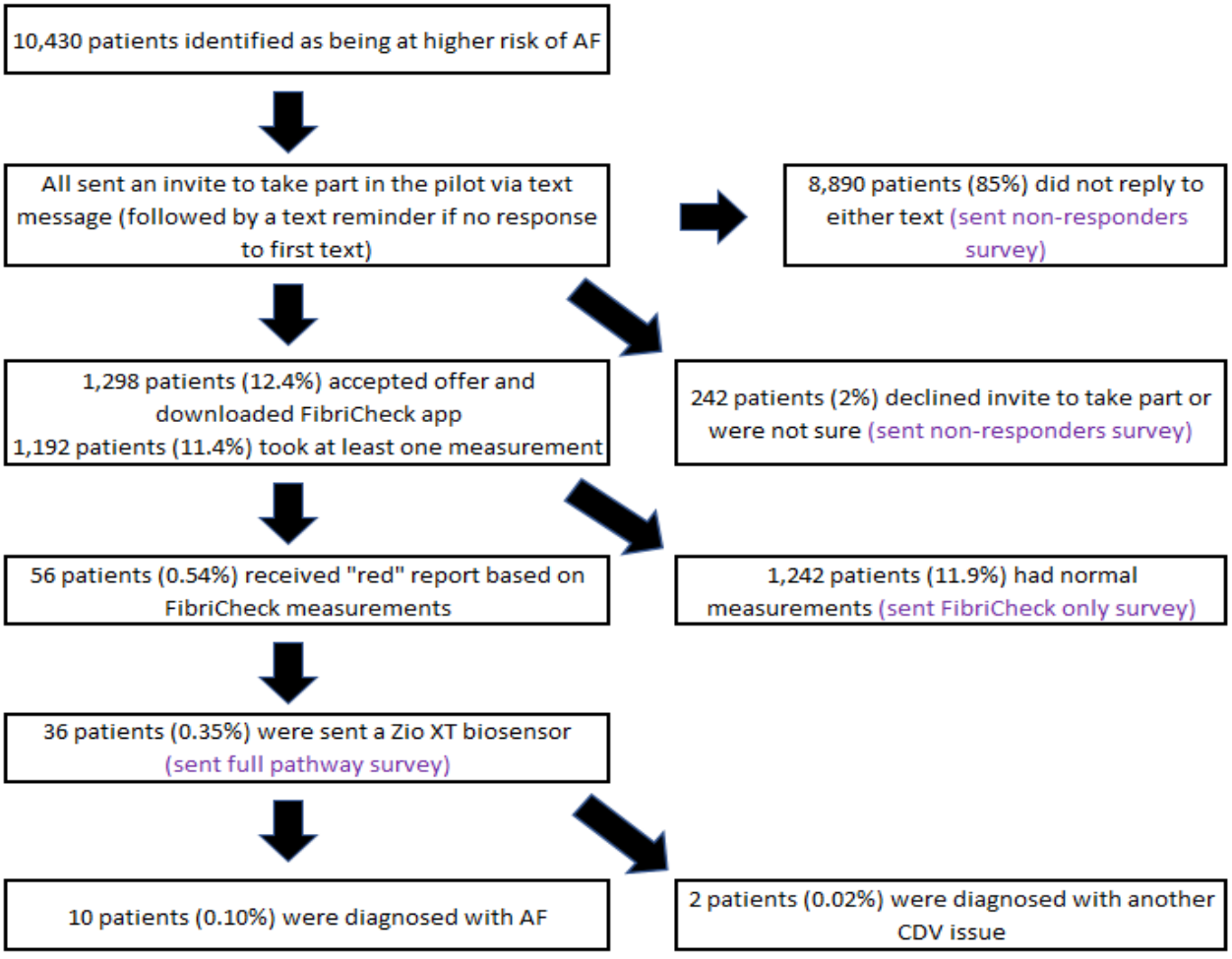
An invite to take part in the pilot was sent to 10,430 people via text message, followed by a second text reminder if there was no response to the first text:

- 8,890 did not respond to either text message.
- 1,298 downloaded the FibriCheck app and 1,192 took at least one measurement.
- 56 recorded a “red” report based on the heart rhythm measurements taken.
- 36 were sent a Zio XT biosensor patch (i.e. went through the complete pathway).
- 20 were not sent a Zio XT patch as when their records were checked they had already been diagnosed with AF.

Three online surveys were designed and set up on the Qualtrics online survey platform. A link to the relevant survey was sent via text to all those who had been sent the text invite to take part in the pilot, as follows:

- Full pathway survey (i.e. sent to those who had abnormal readings from the FibriCheck app and were sent a Zio XT patch): 17 responses (30% response rate).
- FibriCheck only survey (i.e. sent to those who had downloaded the FibriCheck app but had normal readings and required no further follow up): 438 responses (39% response rate).
- Survey of non-responders (i.e. sent to those who had not responded to the text invite to take part in the pilot): 532 responses (6% response rate).

The flow diagram below shows the number of patients at each stage of the pathway and which survey they were sent (percentages are based on the 10,430 patients sent a text invite).



The survey responses were downloaded into Excel and the frequencies were analysed. Free text comments were coded using thematic analysis.

Two focus groups were held in Bury St Edmunds in November 2022 with patients who had gone through the complete pathway: one group had 6 participants (5 female and one male) and the second had 2 participants (both male). After obtaining consent to participate, the focus group discussions were recorded and then transcribed and analysed using thematic analysis. A thematic coding framework was developed following familiarisation with the transcripts and broadly followed the interview guide.

Feedback from professionals involved in the pilot
Virtual interviews were conducted in October 2022 with the 3 key staff at West Suffolk Foundation Trust who were involved in running the pilot:

- The consultant cardiologist.
- The cardiology charge nurse.
- The Public Health consultant.

Ethics
Ethical approval was provided for all elements of the project by the University of Essex Ethics Sub Committee 2.

Executive Summary

The University of Essex was commissioned by Eastern AHSN to evaluate the AF remote monitoring pilot in Suffolk. The evaluation used a mixed method approach to assess the outcomes of the pilot and gain insights into how the process has worked for patients and professionals. This report presents evaluation findings from the activities undertaken at West Suffolk NHS Foundation Trust.

Data analysis

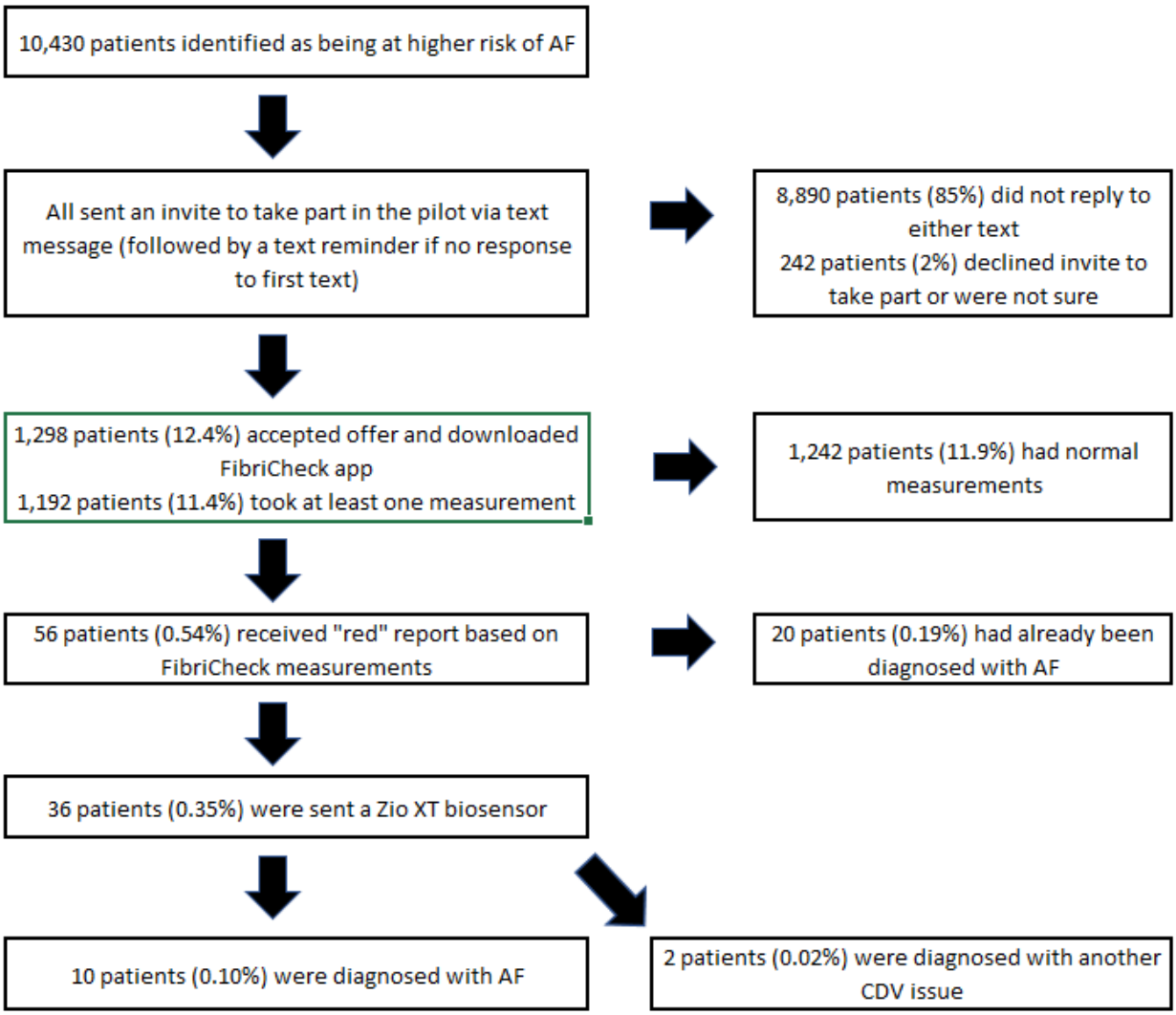
NB: FibriCheck data shows 1,417 people downloaded the app, but this number is only available at an aggregate level whereas the data supplied by WSFT for analysis by the University is at individual patient level and shows that 1,298 people downloaded the app.

While this pilot was not intended or structured to close the diagnosis gap set out by the AF Data Tool[5], 0.77% (n = 10) of individuals who engaged with the pilot (n=1,298) were diagnosed with AF. To meet the 85% target set within the AF Data Tool, 404 individuals must be diagnosed with AF - so about 52,440 individuals must engage in a similar pilot for this number to be diagnosed.

All of those diagnosed with AF (n=10) were aged between 66 and 85 years old (7 were between 71 and 80), 7 were men and 3 were women. 7 had a risk score of 3 or less and 2 out the 10 lived in the most deprived 30% of wards.

The proportion of those aged under 60 who engaged with the pilot (21%, n=108) was significantly higher than the total cohort while the proportion of those aged 81 and over who engaged (5%, n=119) was significantly lower. Significantly fewer patients with a risk factor of 4 or 6+ (9%, n=229) and from the White Other ethnic group (9%, n=37) engaged.

[5] As presented in the AF Data Tool, https://aftoolkit.co.uk/af-data/af-data-tool/ - results for the latest year of data, 2019/20. This data for W Suffolk shows 1,649 people potentially undiagnosed with AF, which is 5% below the Public Health England and NHS England ten year cardiovascular disease ambitions of 85% detection for 2019/20 and 1.8% below the national average of 81.8. In addition, 414 people with AF need to be diagnosed to reach the 85% detection target.



Data sampling for potential patients at higher risk of AF

Data on potential participants in the pilot was restricted to patients known to the WSFT, i.e. mainly patients who had been in contact with the hospital but also those known to the Trust's community services and those registered with the general practice managed by the WSFT. This has limited the population cohort within the pilot as the data covers people with a health issue attending the hospital or community services as opposed to targeting the general population.

The Public Health consultant identified some of the challenges of using the CHA2DS2-VASc scoring[6] as the risk for an AF marker as using something simple such as age over 65 plus hypertension or history of heart disease as the biggest risk factors may have sufficed. A two-step filtering process – on age and macro cardiovascular disease factors first and then filtering on CHA2DS2-VASc scores afterwards – may have been acceptable.

The resulting list of eligible participants was further stratified according to risk with those with the highest risk score progressing through the pathway first. Learnings from the

[6] The CHA2DS2-VASc score is used to assess the risk of stroke in people detected with AF.

uptake of these participants were used to inform the changes to the information communicated and the recruitment approach throughout the pilot.

There were a small number of issues with the quality of the electronic health records used where either an AF diagnosis had not been coded properly into the record or AF had been diagnosed between taking the snapshot of the live data and contacting patients. A proportion of the texts (up to 3%) were sent to unintended recipients where either the phone number of adult children of elderly parents was recorded as the parent's actual number or a number of older couples share a mobile phone: it was not possible to include an identifier in the message.

Communicating the heart rhythm checks

A total of two text messages were used to drive participation in the pilot on an opt in basis: the first was to inform people about the pilot and the offer to participate, and the second was a reminder to activate the offer.

Patients identified as being at higher risk were sent the first text message, followed by a reminder if they did not respond. The text stated it was from WSFT with a link to information and to an online portal hosted by the DrDoctor service. However, although the DrDoctor system is in use by WSFT, it does not come from an NHS service.

The scope of the pathway was to minimise participant contact with the hospital, however this left people without a way to validate or verify the offering and the DrDoctor character length constraints restricted the amount of information within a single text message. This resulted in the trialling of several alternative approaches to inform patients through other communication channels, such as letters. It was agreed that the activation rates were no better or worse than via text, so the additional resource required to facilitate other communication routes was not a viable option.

Those responding ‘yes’ to the initial text received an automatic text back with a link to the license-paid full version of the FibriCheck app. Those responding ‘no’ were not sent any further texts. Those responding ‘unsure’ were included in the reminder set of messages, unless they added a comment about why they were unsure which meant that the methodology would be unsuitable for them (e.g. no access to a smartphone or being very ill). A second text was typically sent seven days later to those who had not responded at all and to those who had said they were unsure.

An issue arising from the automatic text sent after ‘yes’ replies was that this arrived immediately but people were expecting to be sent a separate text with the link and more information rather than having this as part of the automated response, and therefore they did not see the information to proceed with the pilot.

Reactions to initial text invite

12.4% of the 10,430 patients contacted accepted the offer and downloaded the FibriCheck app, a response rate that the Public Health consultant felt was *“phenomenal”* for this kind of cold contacting. However, around half of those who replied ‘yes’ to the text did not go onto sign up for the FibriCheck app, which may have been partially due to them missing the link in the automated reply text.

Several focus group participants thought the initial text might be a scam so deleted or ignored it and only replied when they got the reminder. Several wondered why they had

been sent the text and what the criteria was for selecting people to invite. They felt including information about why they had been chosen might help increase the number of people taking up the offer.

Reasons for not taking up the offer

Respondents to the University of Essex survey of those who did not respond to the text invite provided 473 comments about why they decided not to download and activate the FibriCheck app. The first broad theme was around technological issues (also identified as a barrier by the Public Health consultant): 16% of comments (n=76) were that respondents do not have a smartphone. 11% (n=52) said they just did not want to take up the offer and 5% (n=24) that the idea did not work for them. The Public Health consultant reported some people experienced issues as they thought they needed a code to log into the FibriCheck app. This could perhaps account in part for the other 11% (n=52) of people who said they could not use or download the app or were no good with technology.

The second broad theme was around the information not being received: 15% (n=71) of comments were that respondents did not know anything about the pilot or had not received/ been sent information about it. Another 9% (n=43) did not remember a text, 2% (n=10) did not read it and 5% (n=24) forgot to respond or were too late in replying to the text to activate the licence.

10% of comments (n=47) were that respondents did not understand the information and 8% (n=38) were concerned that the text was a scam (also identified as an issue by the Public Health consultant). 10% (n=47) did not take up the offer as they were already receiving treatment and/ or checks for a heart condition, so these checks were not needed. 4% (n=19) had not been able to sign up at that time due to other health conditions and another 5% (n=24) gave other reasons (e.g. being away) for not taking it up. 5% (n=24) said they were not eligible, mainly as they had moved out of the area. 3% (n=14) highlighted that the phone number the text was sent to was either shared or the text was intended for another member of the family and 3% (n=14) said that the pilot was not suitable or that the checks were not relevant for them. 1% (n=5) thought there would be a cost to using the app. The Public Health consultant also identified concerns about the money element (which may have been because participants accessed the FibriCheck app directly, where it does ask for financial information, rather than clicking through the link, or they misunderstood).

Respondents to the survey of those who did not reply to the text invite suggested information that might have been useful to them in deciding whether or not to take up the offer, with the main ones being:

- There was no way of asking for help if people were having difficulty in registering or accessing FibriCheck (some said they would need to ask a member of their family to help them).
- The information/instructions on how to take up the offer should have been available via email, computer or other method.
- Having a letter or phone call about the pilot.
- Having a way of confirming the text's validity.
- Specific information including how the app works or the type of phone it can work on, what would be involved or simple instructions about how to download the app/scan the code.

- Why the respondent had been chosen for the pilot, whether the checks would be useful for someone with their specific condition and what would happen to the results.
- Including the name of the person being invited.

Of the 101 other comments made by respondents to the survey of those who did not reply to the text invite, 26% were that the pilot is a good idea, 52% were that respondents would like to sign up now if the opportunity is still available and 14% that they would have signed up for it if they had seen/received the information. 12% were that respondents would have liked to participate but were not able to do so, either due to technology issues or other things going on.

Knowledge about Atrial Fibrillation

Over half of all respondents (to both surveys) did not know much or anything about AF prior to being contacted. After reading the information sent about AF and the heart rhythm checks, around 40% of those providing a response said they had a 'slightly better' understanding of AF. Another 6% of those who had downloaded the FibriCheck app and 16% of those who did not reply to the text invite had a 'much better' understanding.

While half of the respondents who had downloaded the FibriCheck app had looked at the information about AF and heart rhythm checks on the hospital's website only 14% of the non-responders had done so. Those saying they did not know much or anything about AF prior to being contacted were slightly less likely to say they had looked at the information about AF on the website.

Everyone who rated the information on AF on the hospital's website rated it as 'very good' or 'good'. Focus group participants felt that the information on the website was clear. Very few suggestions were made about anything that could be improved about the website or any other information that patients would have found useful.

Activitating and using the FibriCheck app

92% (n=375) of respondents said that it was 'very easy' or 'easy' to register with the FibriCheck app and activate the free licence. The reasons given about why it was not easy were that the process was not strightforward for the respondent, they had difficulty in doing so or they struggle with technology. Several people had problems registering or downloading the app and needed to phone for help while some had got a son or daughter to support them. A number of people had difficulty accessing the free trial, and got to the website where the app would have cost money.

91% (n=355) of respondents said it was 'very easy' or 'easy' to use the Fibricheck app to monitor their heart rhythm. The main difficulties mentioned about using the app were due to difficulties in getting their finger in the right position (with some saying that this was due to the layout of their phone and placement of the camera) or it being difficult to get a reading/the reading jumping. A few could not use the app as their signal was poor or intermittent or had general difficulty in getting the app to work. Some could not register any readings. One person said that when the results were available, they had forgotten the password so they did not get any results: they queried why a password was needed.

The majority of survey respondents who had downloaded the FibriCheck app but not gone on to receive a Zio XT patch were satisfied overall with using the app to monitor their own heart rhythm, with 43% (n=166) being 'very satisfied' and 48% (n=186) being

‘satisfied’. However, 9% (n=35) said they were dissatisfied. All of those who had gone through the complete pathway were satisfied overall with using the app.

The main reason why respondents were satisfied with the FibriCheck app was that the app was easy or simple to use (84 of the 180 comments made). 42 comments highlighted that the checks had provided reassurance, 29 were that the checks are a good idea, 28 that the results and advice were clear and 19 that respondents had normal readings. However, another 11 comments were that respondents wanted to have more information or follow up about any abnormal readings that occurred.

43 respondents provided a reason for being dissatisfied with the app, mainly that: they had difficulties in getting the app up and running or problems in using it; they received no feedback about the results or the app did not really tell the respondent if their heart was OK; the FibriCheck licence expired too soon and that more time was needed; and the app would cost them money after one week. Two survey respondents and several focus group participants wondered whether a week using the app was long enough to pick up AF when for some people the irregular heartbeats happen intermittently.

110 of the survey respondents gave a comment when asked if there was anything else they would like to say about the FibriCheck app. Just over half were that the app is a good idea, easy to use and useful, replicating comments made under earlier questions. 16 people commented about the cost of the app: that it should be free to use after the pilot; that they did not want to pay to use it after the pilot; or that it was too expensive. Eight said that the app should be available for a longer period of time, and 3 said it should be available to everyone. Three respondents suggested the results from the app should be sent to their GP and/or monitored by a health professional. Three suggested that providing help or support is needed for some people, e.g. a phone number to ring.

Following up those identified with potential AF

The cardiology nurse encountered a few barriers when contacting patients, mainly that he could not get hold of them or it took several days to get hold of them: ensuring a prompt contact with patients is important and sending a Zio XT patch before having spoken to a patient was not recommended. One improvement made to the process was to have two phone conversations with patients, rather than trying to explain about the Zio XT patch before they had seen it. The nurse had a follow up contact with later patients in the middle of the Zio XT patch period to ask them how they were getting on and whether they had found any issues. Focus group participants felt this follow up phone call provided useful reassurance that all was well.

All of the survey respondents (n=17) who had gone through the complete pathway felt that the virtual conversation before they were sent the Zio XT patch was useful, with 13 saying it was ‘very useful’ and 2 saying it was ‘useful’. The focus group participants described the cardiology nurse as very helpful, patient, reassuring and clear with his instructions.

Having a remote consultation

Remote monitoring as an approach was seen as being acceptable by healthcare professionals from WSFT since the Zio XT patch produced high quality readings and meant that the cardiology nurse was able to get in touch immediately, arrange blood tests and start patients on medication. The virtual approach was convenient for the patients as

they did not have to leave home to go to the hospital, but was not as ideal for clinicians since they were unable to check that processes and instructions were being followed.

The healthcare professionals felt a key success factor was having good communication with patients. The phone consultations enabled the reassurance of any concerns, explanation of certain aspects and answering of their questions. This also helped with patient engagement in the pilot. However, if the checks were to be offered on a bigger scale, then this activity would need to be done by a team of people rather than just one nurse.

Five out of the six participants in one focus group were happy to have consultations with the nurse by phone. Both of those in the other focus group accepted having a phone or virtual consultation as (since Covid) this is how they usually have contact with their GP, even though they would prefer to see someone in-person. Several would have preferred a consultation via FaceTime as this would have enabled the nurse to see what they were doing while fitting the monitor and be able to demonstrate what to do. One also said that they were hard of hearing so that being able to see someone on a FaceTime call would have made it easier to hear and understand what was being said. However, one participant did not know how to FaceTime so preferred a phone call.

Using the Zio XT biosensor patch

Most of the survey respondents who had gone through the complete pathway said it was easy to apply the biosensor patch (n=13) but 2 said that it was ‘not very easy’. One person in the focus groups would have preferred to have gone to a clinic to have the monitor fitted in-person, but said that the nurse was very helpful in talking them through the whole process so they did not have any problems fitting the monitor.

All but one of the survey respondents who had gone through the complete pathway were satisfied overall with using the Zio XT biosensor patch but one patient was dissatisfied, saying that it was difficult to keep it attached to their chest and that the adhesive caused irritation. Three patients in the focus groups said they had a very red and/or sore area of skin after taking off the monitor, including one person who suffers from eczema. Two focus group participants had difficulties in getting the monitor off at the end due to the adhesive strength. Three survey respondents and all of the focus group participants had problems with showering or bathing while wearing the monitor and trying to keep it dry. However, 4 survey respondents said it was easy to use and wear and another said it was very comfortable to wear and more resistant to water than they had thought.

Cardiology consultant follow up

Six survey respondents were invited to attend a virtual consultation with a cardiology consultant after using the Zio XT patch. Three of these patients said they were happy to have a virtual consultation, one said they did not really have any preference and two would have preferred an in-person consultation.

Diagnosis of Atrial Fibrillation

The pilot has succeeded in identifying 10 new cases who are now receiving treatment. The public health consultant highlighted that although this may not appear to be a large number, applying assumptions about the likelihood of a stroke in a given population indicates that for those 10 people one stroke over the next two years has been

prevented. Preventing one stroke case has significant associated human benefit as well as cost savings for the system[7]. The pilot picked up a number of patients (who were likely to have been seen by the cardiovascular clinic in the future) who have benefitted from an earlier diagnosis of AF because of the pilot.

Two patients out of the 10 identified as having AF were diagnosed with the condition but had no noticeable symptoms so would not have been identified via the traditional routes of showing symptoms, going to a GP and being referred to a cardiologist. There were also a number of patients with arrythmias that the Zio XT patch was able to pick up but who did not necessarily need treatment.

The two cardiology professionals felt the pilot has certainly identified patients whose first presentation of symptoms is likely to have been a stroke, but the rates are not as high as they might have expected. One area for investigation is why the Zio XT patches had a lower number of positive readings than the FibriCheck app. Two focus group participants said the monitor had not picked up any arrhythmia for them, which was concerning as they are not sure whether the app picked up arrhythmia but the arrhythmia was not present while wearing the monitor, or whether the app was not accurate.

Satisfaction with the pilot

For four focus group participants, the actual outcome of the pilot was a success since otherwise they would not have been diagnosed with their condition. Almost all of the participants in both groups said that any testing or preventative pilot such as this one is a good idea as it could save lives. Patients in the second focus group asked whether the testing would be repeated as they could see its value.

Several focus group participants were in favour of technology that is well designed, is straightforward and can identify an issue. However, they recognised that not all older people are as confident with or as willing to use technology.

Value of the pilot

Professionals saw the pilot as successful and very useful in identifying people with AF. It would be beneficial to modify the approach used based on the current evaluation and run it again so that, with greater awareness of the pilot project, people who originally declined might now accept the offer.

The professionals felt the pilot demonstrated that the remote monitoring approach was acceptable to an older population, as the response rate was very good, and that there is a massive potential to use this kind of digital approach with an elderly population. Repeating the testing would be very valuable and have a large potential return on investment since people can be asymptomatic or have symptoms that are intermittent, hence not easily detected through traditional monitoring. The cardiology consultant suggested that rolling the at home heart rhythm checks out further will depend on the costs, as the yield has not been high enough to say definitively that it is worth it. However, they can see a value in using the Zio XT patch for post stroke patients who currently are given a seven day event recorder which is not as good.

[7] The mean cost of new-onset stroke is £45,409 in the first year after stroke and £24,778 in subsequent years.

Improvements to the pilot

The following are suggested improvements to patient identification and communications:

- Collect data at the patient record level more consistently and be very clear about who phone numbers belong to.
- Implement a communications strategy for healthcare staff and the wider population to reassure that it is a legitimate health campaign rather than a scam.
- Consider small tweaks to reassure recipients that this is not a scam, such as some form of NHS branding to the text, sending an NHS branded letter in advance, providing a phone number to ring for reassurance or redirecting to a specific NHS web page.
- Include information about why recipients of the text had been chosen for the pilot, whether the checks would be useful for someone with their specific condition and what will happen to the results.
- If possible, tweak the DrDoctor service to: include an identifier about which patient is being contacted; remove the ‘unsure’ option; and have a delay in sending the automated response text containing the link.
- Provide information about the process within the reply text to avoid people thinking they needed a code to log into the FibriCheck app. A separate activation code text could work better than the clickable link within the automated response.
- Provide information about each step of the process and what to expect, including how the app works, the type of phone it can work on, what would be involved or simple technical instructions about how to download the app/scan the code. Consider whether this information could be available via email, computer or other method.
- Offer clearer instructions and guidance on how to get help if people have difficulty in registering or accessing FibriCheck.
- Keep the FibriCheck licence open for two weeks, both after the first text and also after the prompting text.
- Send a letter to patients registering as red on the FibriCheck dashboard who are difficult to contact.
- Provide some information about the Zio XT patch in terms of what it is monitoring, what sort of results might arise and what will happen next.
- Consider whether it might be possible for people to continue using the FibriCheck app while wearing the Zio XT patch to compare whether both or just one is indicating AF or other arrhythmia.
- Improve the information given to all patients about the Zio XT patch, including that: the patch is water resistant, can be worn while showering and does not need to be kept dry; instructions for showering and bathing with a Zio XT patch are detailed in the patient booklet which comes with the monitor; that the patch has a symptom trigger button on the monitor itself which can be used to log the presence of symptoms if the patient is unable to write in the diary; and patients can use the adhesive remover available in the back of the patient booklet which accompanies the patch.

Other suggested improvements to the pathway are as follows:

- Is it possible for patients to be able to talk to or write notes on an app on their phone, or press a button on their phone, to record when something happened while wearing the Zio XT patch that made them breathe more heavily (rather than having to write notes in the book)?

- Further analysis is needed to understand why 36 patients were flagged as higher risk through a red report by FibriCheck and sent a Zio XT patch but only 10 of these were diagnosed with AF.

NB: These suggested improvements are based on the evaluation feedback collected. It should be noted that the pilot has been iterative in nature so that a number of these recommendations have already been addressed as part of the ongoing co-design with stakeholders, including suppliers.

Data analysis

The specific objectives of this statistical analysis were to assess:

1. The proportions of individuals diagnosed with AF (Atrial Fibrillation)
2. The proportion of individuals who must be diagnosed to meet Public Health England's target of 85%.
3. Any differences in engagement among groups of patients (i.e., age, gender, ethnicity, index of multiple deprivation, and risk score)
4. Any differences in AF diagnosis among groups of patients (i.e., age, gender, ethnicity, index of multiple deprivation, and risk score).

This section presents the results of the analysis. Table 1 is a summary of the relevant variables, namely AF diagnosis, gender, age, and engagement in the pilot. The summary in this table presents results on the first objective and provides a basis for understanding the results on the other objectives.

In Table 1, 0.1% (n=10) of the cohort were diagnosed with AF. This proportion is equivalent to 0.77% of the number of individuals (n=1,298) who engaged in the pilot. About 0.27% (n=28) of those who engaged were not diagnosed with AF (despite recording a "red" report based on the heart rhythm measurements taken) whereas 0.17% (n=18) were recorded as having a known AF.

31% (n=3,211) of the total cohort were men and 69% (n=7,173) were women. Finally, about 12% (n=1,298) of the cohort engaged in the pilot. **Regarding the first objective of the analysis, 0.77% (n=10) of those who engaged were diagnosed with AF.**

The number of individuals who must be diagnosed to meet the 85% target for West Suffolk of 414:

- Number of individuals engaged = 1,298.
- Number of diagnoses = 10.
- The ratio of the number of individuals diagnosed to those who engaged = 10:1,298.
- Number of individuals to be diagnosed to meet the above target = 414 – 10 = 404.

The approximate number of individuals who must engage in a similar pilot for 404 people to be diagnosed with AF is about 52,439 [i.e. (404/10) * 1,298]. Thus, regarding the second objective, about 52,439 individuals with unknown AF must engage in a similar pilot for the remaining 404 people to be diagnosed with AF to meet the target of 85%.

Table 1. Summary statistics on relevant variables

Variable	Characteristic	Frequency (n)	Percent
Age (years)	Under 60	510	4.89%
	60-65	569	5.46%
	66-70	1508	14.46%
	71-75	2273	21.79%
	76-80	3246	31.12%
	81-85	1407	13.49%
	86-90	635	6.09%
	Above 90	282	2.70%
Gender	Male	3211	30.79%
	Female	7173	68.77%
	Missing	46	0.44%
Engagement	Didn't engage	9132	87.56%
	Engaged	1298	12.44%
AF diagnosis	AF diagnosed	10	0.10%
	Known AF	18	0.17%
	AF not diagnosed	28	0.27%
	Did not receive 'red' report from FibriCheck app	10374	99.46%
Ethnicity	White - British	8800	84.37%
	White - Other White	395	3.79%
	Asian/African and Others	1185	11.36%
	Missing	50	0.48%
Risk score	2	1516	14.53%
	3	5794	55.55%
	4	2276	21.82%
	5	616	5.91%
	6+	222	2.13%
	Missing	6	0.06%
Deprivation (IMD)	Most deprived 30%	2775	26.61%
	Middle levels of deprivation	7211	69.14%
	Least deprived 30%	398	3.82%
	Missing	46	0.44%
	Total	**10430**	**100.00%**

Note: AF – Atrial Fibrillation; IMD – Index of Multiple Deprivation

Table 2 is a cross-tabulation showing results for objective 3. In this table, 79% (n=402) of patients under 60 years did not engage whereas 21% (n=108) of this group engaged. There was a significant difference between these two proportions, which means the proportion of those under 60 who engaged was significantly higher. The proportion of those over 81 (5%) who engaged was significantly lower: engagement decreased as patients' ages increased. Significantly fewer patients with a risk factor of 4 or 6+ (9%) and from the White Other ethnic group (9%) engaged.

Table 2. A cross-tabulation of engagement against patient characteristics

	Engagement		Total	Engagement	
Group	Not engaged	Engaged		Not engaged	Engaged
Below 60	402	108	510	79%	21% **
60-65	443	126	569	78%	22% *
66-70	1248	260	1508	83%	17% **
71-75	1941	332	2273	85%	15% **
76-80	2893	353	3246	89%	11% **
81-85	1316	91	1407	94%	6% ***
86-90	610	25	635	96%	4% ***
Above 90	279	<5	-	99%	1% ***
Total	9132	1298	10430	88%	12%
2	1248	268	1516	82%	18% **
3	5073	721	5794	88%	12% **
4	2064	212	2276	91%	9% ***
5	542	74	616	88%	12% **
6+	205	17	222	92%	8% ***
Total	9132	1292	10424	88%	12%
Male	2789	422	3211	87%	13% **
Female	6304	869	7173	88%	12% **
Total	9093	1291	10384	88%	12%
White - British	7663	1137	8800	87%	13% **
White - Other White	358	37	395	91%	9% ***
Asian/Africa and others	1068	117	1185	90%	10% **
Total	9089	1291	10380	88%	12%
Most deprived 30%	2503	272	2775	90%	10% **
Middle levels of deprivation	6271	940	7211	87%	13% **
Least deprived 30%	319	79	398	80%	20% **
Total	9093	1291	10384	88%	12%

Key:

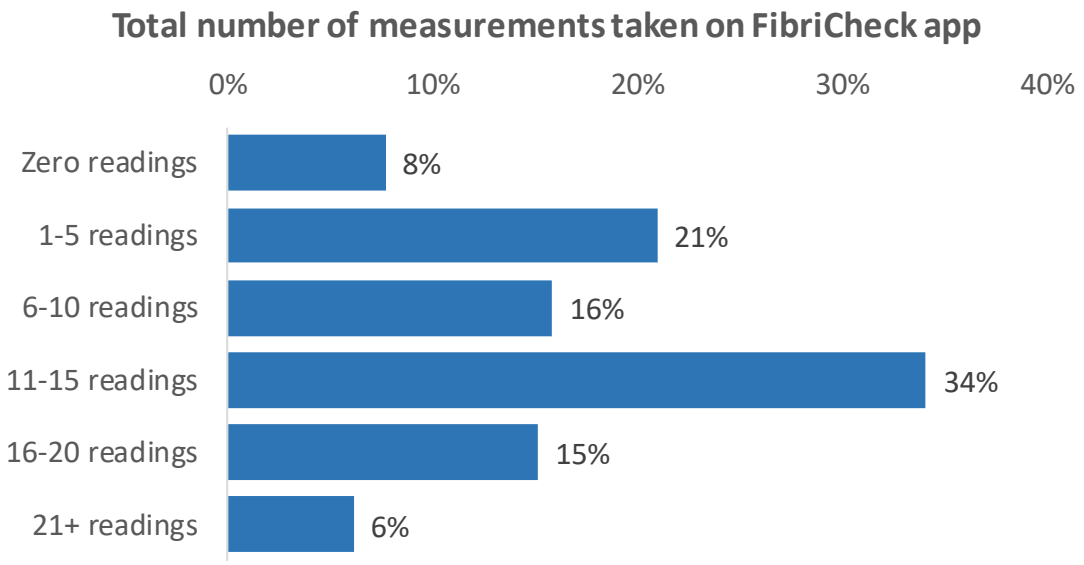
***	p< 0.001 difference is extremely significant
**	p<0.01 difference is very significant
*	p<0.05 difference is significant

Table 3 shows results for objective 4 and is a cross-tabulation of AF diagnosis against the patient characteristics. In the table, all of those diagnosed (n=10) were aged between 66 and 85 years old (7 were between 71 and 80) while 7 were men and 3 were women. 7 had a risk score of 3 or less and 2 out the 10 lived in the most deprived 30% of wards.

Table 3. A cross-tabulation of AF diagnosis against patient characteristics

Group	AF diagnosis			Total	AF diagnosis		
	AF diagnosed	Known AF	AF not diagnosed		AF diagnosed	Known AF	AF not diagnosed
Below 60	0	1	0	1	0%	100%	0%
60-65	0	2	1	3	0%	67%	33%
66-70	2	0	7	9	22%	0%	78%
71-75	3	3	4	10	30%	30%	40%
76-80	4	7	11	22	18%	32%	50%
81-85	1	3	4	8	13%	38%	50%
86-90	0	2	1	3	0%	67%	33%
Total	10	18	28	56	18%	32%	50%
2	1	2	7	10	10%	20%	70%
3	6	9	12	27	22%	33%	44%
4	2	1	4	7	29%	14%	57%
5	0	1	4	5	0%	20%	80%
6+	1	0	0	1	100%	0%	0%
Total	10	13	27	50	20%	26%	54%
Male	7	9	14	30	23%	30%	47%
Female	3	4	13	20	15%	20%	65%
Total	10	13	27	50	20%	26%	54%
White - British	9	11	24	44	20%	25%	55%
White - Other White	1	2	1	4	25%	50%	25%
Asian/Africa and others	0	0	2	2	0%	0%	100%
Total	10	13	27	50	20%	26%	54%
Most deprived 30%	2	3	8	13	15%	23%	62%
Middle levels of deprivation	8	10	17	35	23%	29%	49%
Least deprived 30%	0	0	2	2	0%	0%	100%
Total	10	13	27	50	20%	26%	54%

The chart below shows the number of measurements taken by each person who downloaded the FibriCheck app. Half took between 6 and 15 readings in total.



Findings from patients

Responders to the invite

All those who had responded to the initial text invite and downloaded the FibriCheck app were asked to complete an online survey, and there were 438 responses in total.

Focus groups were held with 8 patients who had gone through the complete pathway plus a survey was sent to all those who had gone through the complete pathway, which had 17 responses. Due to the small numbers of those going through the complete pathway, the responses are included in this section of the report but are not intended to provide a statistically robust comparison.

Reactions to initial text

Several participants in the focus groups thought that the initial text might be a scam, so deleted or ignored it, and only responded when they got the reminder. However, some people were not worried that it was a scam. One person said that the text specifically stated not to contact their doctor or the hospital, which they felt was very strange.

> *"It was the fact that it was followed up. That made me then take it more seriously. That's a really good ideas, sending a follow up. And then I googled it and found an article in the local paper, talking about it, and that was really helpful."*

> *"A friend told me this morning that she'd received it and just ignored it because she wasn't happy that it wasn't a scam. And then I think she received a second one and she still felt she should ignore it. So but I felt all right about it, I think because it seems to come from the hospital and I have been a patient at the hospital. So I went ahead with it. But otherwise I don't when things come through with links I don't go ahead with them."*

Participants in the first group suggested that if the text had contained some form of NHS branding, or the West Suffolk NHS logo, then this would have helped to reassure them. They highlighted that they tended to be quite suspicious of texts and emails that could be a scam. Other suggestions were to send them an NHS branded letter in advance saying that they would be contacted by text, or to provide a phone number to ring for reassurance.

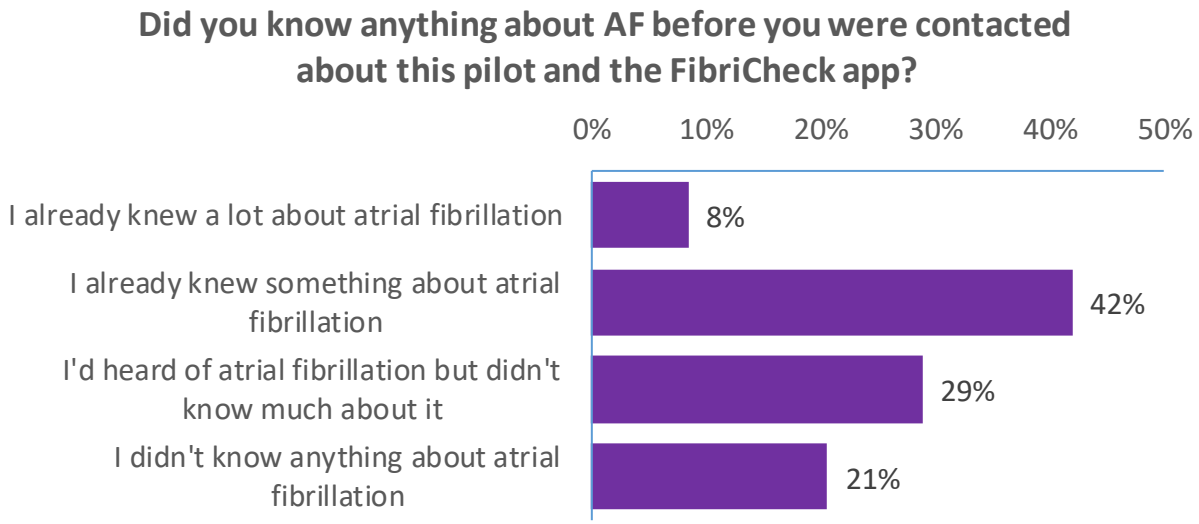
> *"I think we could have all done with a bit more information to realise that it wasn't a scam. And this was quite serious thing."*

Several participants in both focus groups wondered why they had been sent the text and what the criteria was for selecting people to invite. They felt that including some information about why they had been chosen might help increase the number of people taking up the offer.

> *"It just came out of blue a bit didn't it?"*

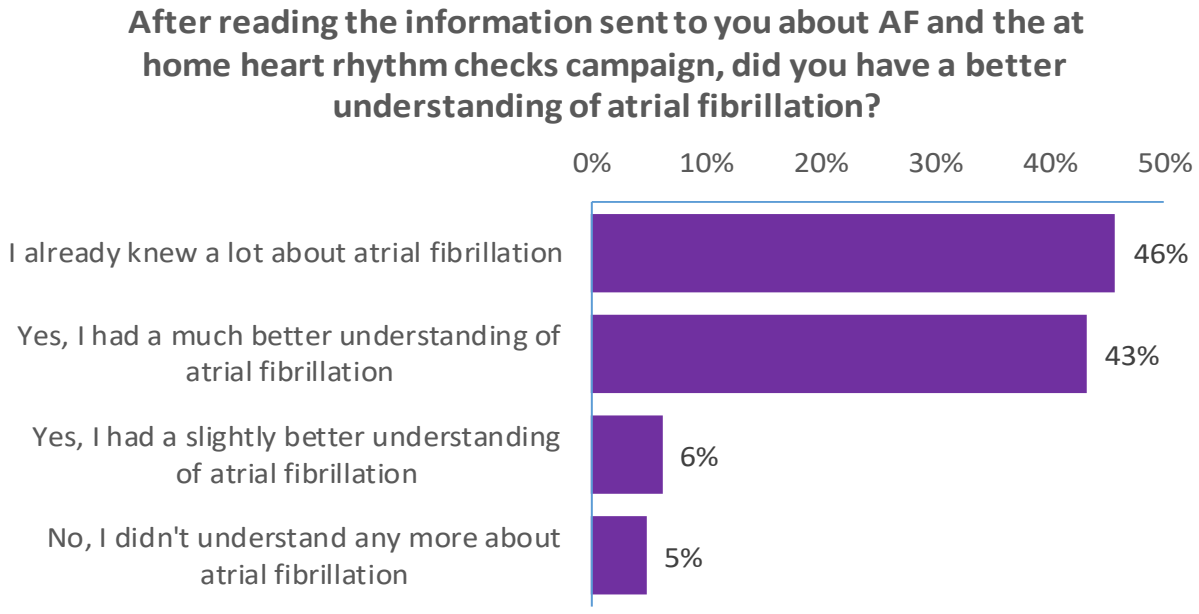
Knowledge about Atrial Fibrillation

Survey respondents were asked whether they knew anything about AF before they were contacted about the pilot. 8% (n=37) said they already knew a lot about AF and 42% (n=183) said they already knew something about AF. However, 50% (n=216) said that they did not know much or anything about AF prior to being contacted.



Four of the 17 survey respondents who had gone through the complete pathway said they already knew something about AF while 13 said that they did not know much or anything about AF prior to being contacted. Some participants in the focus groups already knew something about AF. One had a relative who had just been diagnosed with it while others also had relatives with AF or a family history of it.

When asked whether they had a better understanding of AF after reading the information sent about AF and the at home heart rhythm checks campaign, 43% (n=189) of those providing a response in the survey said that they had a slightly better understanding of AF while 6% (n=27) had a much better understanding. 46% (n=200) said they already knew a lot about AF while 5% (n=21) said they did not understand any more about AF.



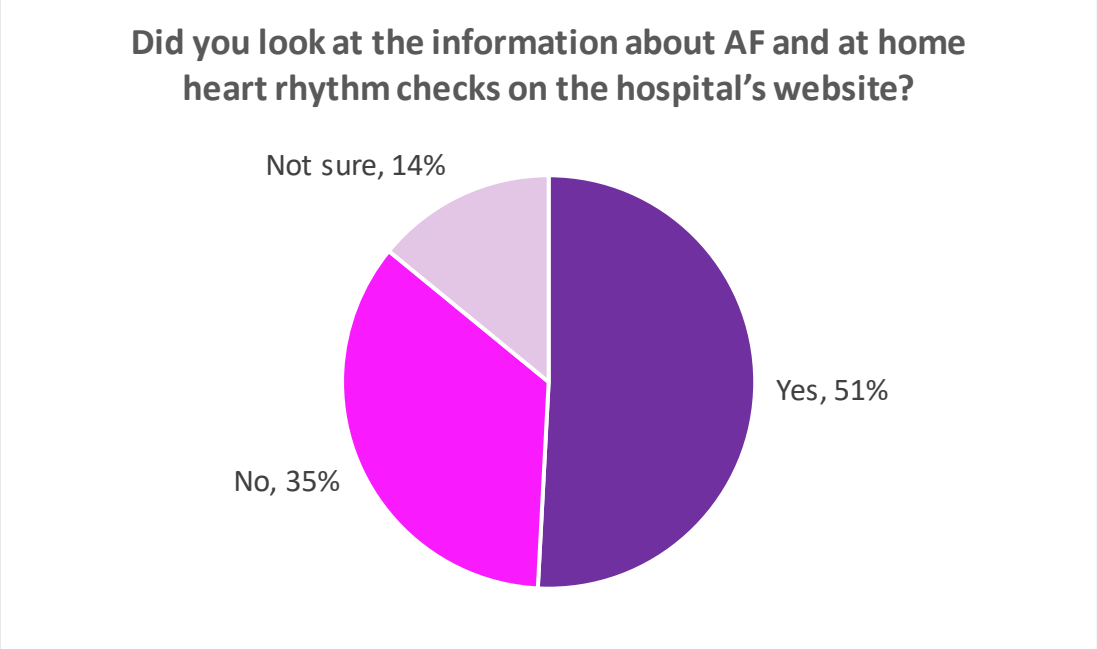
14 of the 17 survey respondents who had gone through the complete pathway said that they had a much better understanding of AF after reading the information and 3 said they had a slightly better understanding. Focus group participants felt that the information on the website was clear and several mentioned the video of a doctor and nurse, which they felt was very good and *"compelling"*. (One person had googled the doctor in the video to check that he was a genuine doctor.)

Some focus group participants knew about AF beforehand due to someone in their family having it, while others had only heard of it and did not know much about it. One person said that the information provided them with more in-depth information.

Two out of the 8 participants in the focus groups had been having symptoms whereas the other 6 had not had any symptoms. One person received the text at a very appropriate time, as they had been having symptoms that they had put down to panic attacks but had assumed it was part of the ageing process and hadn't seen their GP about it. When they received the text and read the information on the website and on Google, they realised that it could be AF.

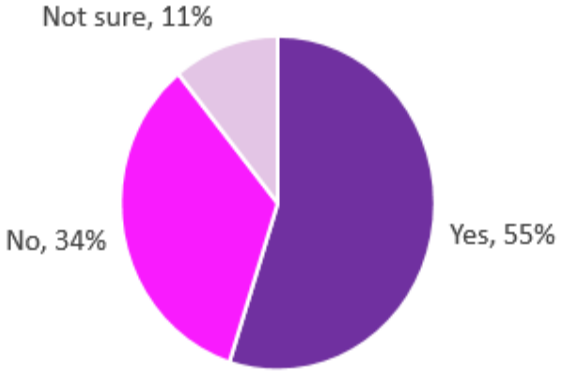
> *"I've been having these for a long time, and I didn't take them seriously. I just thought I'm getting older, and, you know, everything going on in the world. I just thought that I was perhaps having a panic attack."*

Respondents were asked whether they had looked at the information about AF and at home heart rhythm checks on the hospital's website - https://www.wsh.nhs.uk/Services-A-Z/Cardiology/Atrial-fibrillation.aspx?letter=A. Just over half (51%, n=213) said that they had.

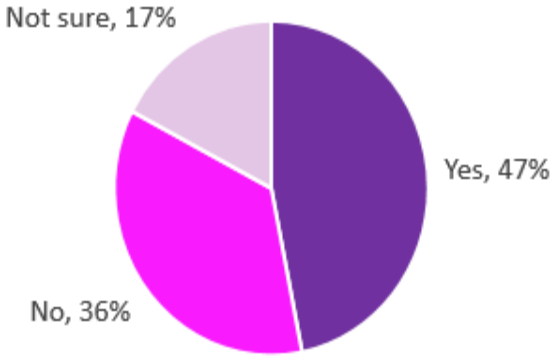


Survey respondents who said that they did not know much or anything about AF prior to being contacted were slightly less likely to say they had looked at the information about AF on the website. Those saying they knew a lot or something about AF were slightly more likely to say that they had looked at the information on the website.

Respondents knowing a lot/something

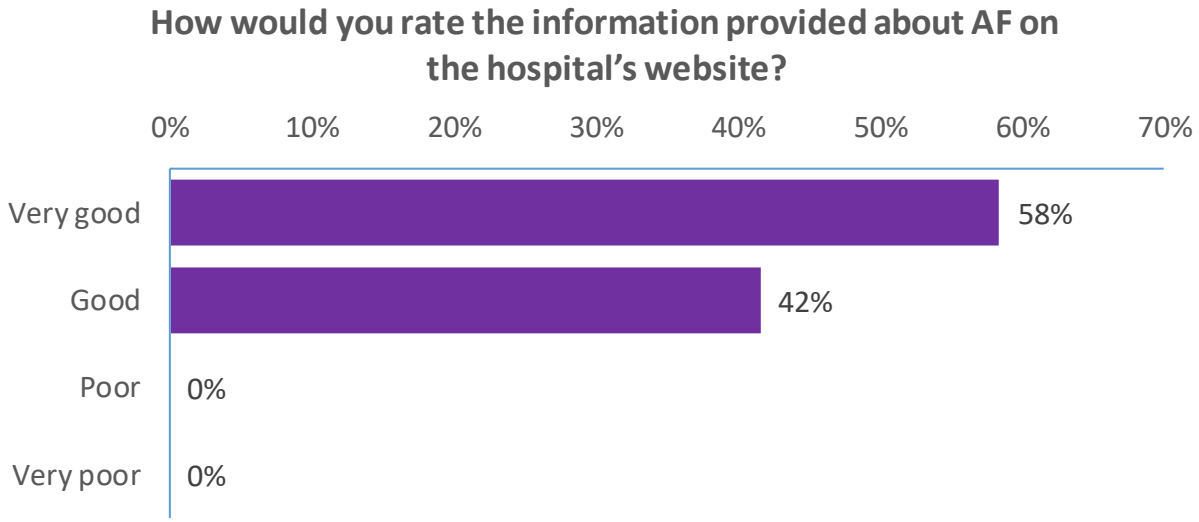


Respondents knowing not much/nothing



Ten of the survey respondents who had gone through the complete pathway said they had looked at the information about AF on the website while 4 did not and 1 was not sure.

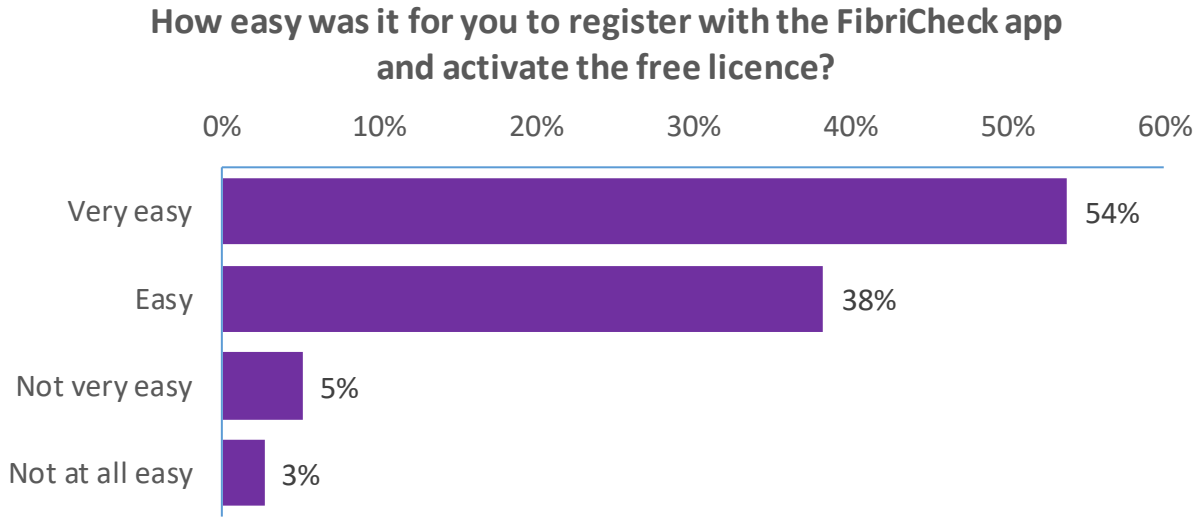
Everyone (n=154) who rated the information provided about AF on the hospital's website (including those who went through the complete pathway) rated it as 'very good' or 'good'.



Very few suggestions were made about anything that could be improved about the website or any other information that would have been useful. Three survey respondents asked why they had been selected as they did not feel at higher risk/have a history of AF. One person said it was a good idea but could not afford to do the checks (due to the cost of FibriCheck). Another said they would have liked to know how long the tests would be going on for in advance as the app *"just stopped after so many sessions with no real explanation".* One person suggested having a way of verifying that the offer was legitimate. One person asked for access to the website at all times.

Activitating and using the FibriCheck app

92% (n=375) of survey respondents said that it was ‘very easy’ or ‘easy’ to register with the FibriCheck app and activate the free licence.



Eight of the survey respondents who had gone through the complete pathway said it was ‘very easy’ to register with FibriCheck and activate the licence while 5 said it was ‘easy’ and 1 person said it was ‘not very easy’ as they were *“not very computer literate”.* None of the focus group participants had any problems in registering and downloading the app, although at least one had help to do so from their children.

Eleven of the people saying that it was not easy to download the app provided a comment about why they said this. Eight people said that downloading the app was not a straightforward process for them or they had difficulty in doing so, while another 4 said that they struggle with technology.

Six people had problems registering or downloading the app and needed to phone for help.

> *“I downloaded the app easily but it took a while to get it functioning. I had to make a few phone calls and no one seemed sure what was wrong.”*
>
> *"Despite numerous attempts to run this app on my phone I was unable to open the file, however I already use the Samsung Health app which offers a similar service.”*
>
> *“I found the whole process very confusing, I was never sure if I was doing it right.”*

Four people said that they got a son or daughter to download it for them.

> *“I was lucky to have my daughter do the download for me, Although I use our iPad regularly I only consider myself to be doing the basics however she did say it was straight forward for her.”*

Four people said that they had difficulty accessing the free trial, and got to the website where the app would have cost money.

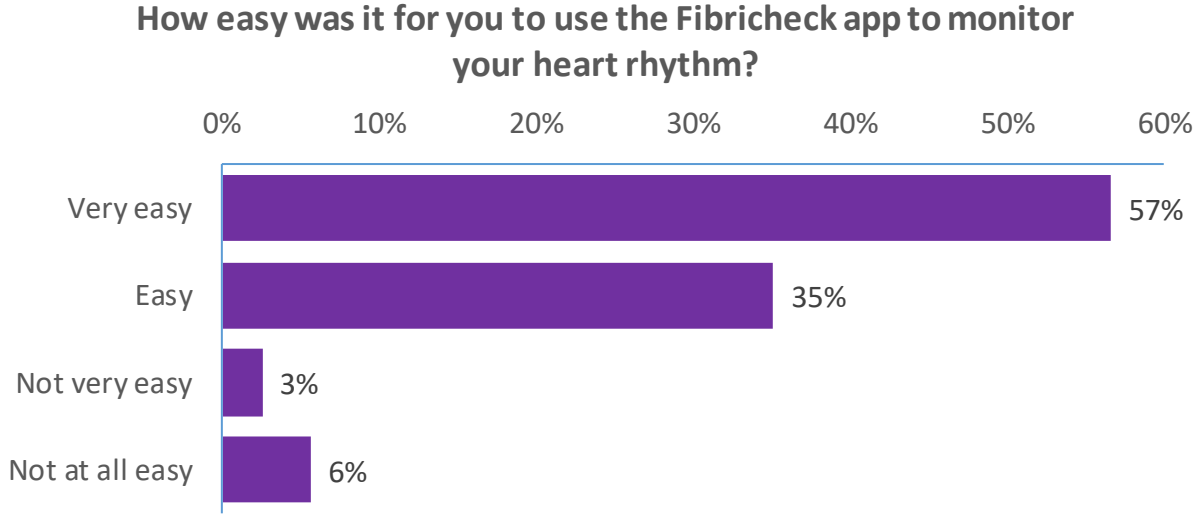
> *"I used the link at registration time to download the app but it wasn't the 7-day trial version, so I emailed your help desk and FibriCheck manually activated my prescription - no hassle, just a bit of confusion getting started."*

One person said that they thought the text was a scam and tried to get in touch with West Suffolk Hospital to check. However, the hospital took nearly a week to respond to by which time they only had one day left of the trial: they suggested that if they had been told of the trail in advance they could have had time to assess whether it was appropriate for them.

Several people in the first focus group said they would have liked a bit more information about the whole process in terms of each step and what to expect, before they downloaded the app.

> *"I think that would have been useful to have a little bit more information… the whole time, I wasn't quite sure what I was doing, whether I was doing it right or not. But I think maybe a bit more information would be useful."*

91% (n=355) of survey respondents said that it was 'very easy' or 'easy' to use the Fibricheck app to monitor their heart rhythm.



Five of the survey respondents who had gone through the complete pathway said it was 'very easy' to use FibriCheck while 5 said it was 'easy' and 1 person said it was 'not very easy' as it was *"difficult to hold finger on camera lens on phone".* Many of the focus group participants thought that the app was straightforward to use and was very clever in reading their heart rate through the phone camera.

> *"I thought it was pretty clever actually, I'm just sort of sticking my finger in the camera and I felt wow."*

However, 2 participants in the first focus group had trouble with using the app to monitor their heart rhythm: one said that the readings jumped if their finger moved while the other sometimes had no readings when they put their finger on the camera so had to take their finger off and put it back on again to obtain a reading.

"Sometimes you put it on the finger and it would just jump all over the place. And then I would take it off and put it back on. It's quite normal, you know, it's back and forth like that. And, you know, if you just move slightly, you could see the jumps in in that way. And the thing was very irregular sometimes."

The main difficulties mentioned by survey respondents about using the app were due to difficulties in getting their finger in the right position (11 people said this, with some saying that this was due to the layout of their phone and placement of the camera) or it being difficult to get a reading/the reading jumping (5 people).

"If your finger moved even a little this affected the signal and gave a false warning. 30 seconds is a long time to keep your finger still. Apple Watch app is better."

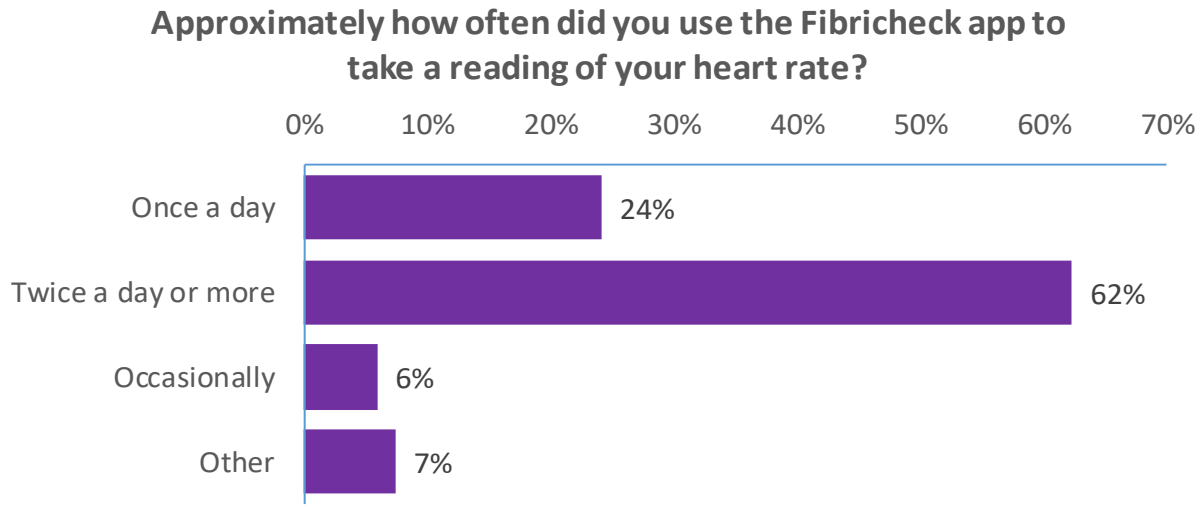
"You can't see where your finger is. Our smart phone has 3 camera lenses behind one larger glass. The test kept stopping as we couldn't keep the right lens on the right place. Sometimes we would get almost to the end and have to start again as many as 6 times. Eventually we gave up. What is needed is to see the image of the finger on the phone screen, to be able to move it on to the target."

"My finger print was difficult to place in the correct position. Sometimes it worked straight away and other times not at all. Frustrating and I abandoned the trial."

Two people could not use the app as their signal was poor or intermittant and 3 others had general difficulty in getting the app to work. Four said they could not register any readings and one could not access the app. One said that they were only able to send one test result as all of the others failed while another said they would like to try the checks again since they were ill at the time so only took one reading.

One person said that when the results were available, they had forgotten the password so they did not get any results: they queried why a password was needed.

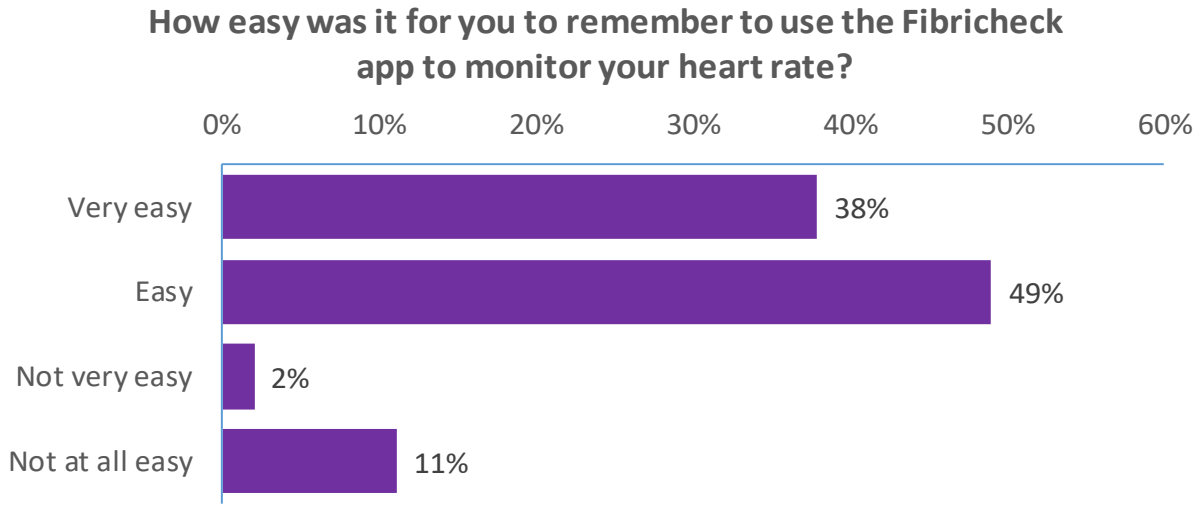
When asked approximately how often they used the FibriCheck app to take a reading of their heart rate, 62% (n=250) of survey respondents said they did this twice a day or more while another 24% (n=97) said they did this once a day.



Eight of the survey respondents who had gone through the complete pathway said they used the app to take a reading of their heart rate twice a day or more while 5 did this

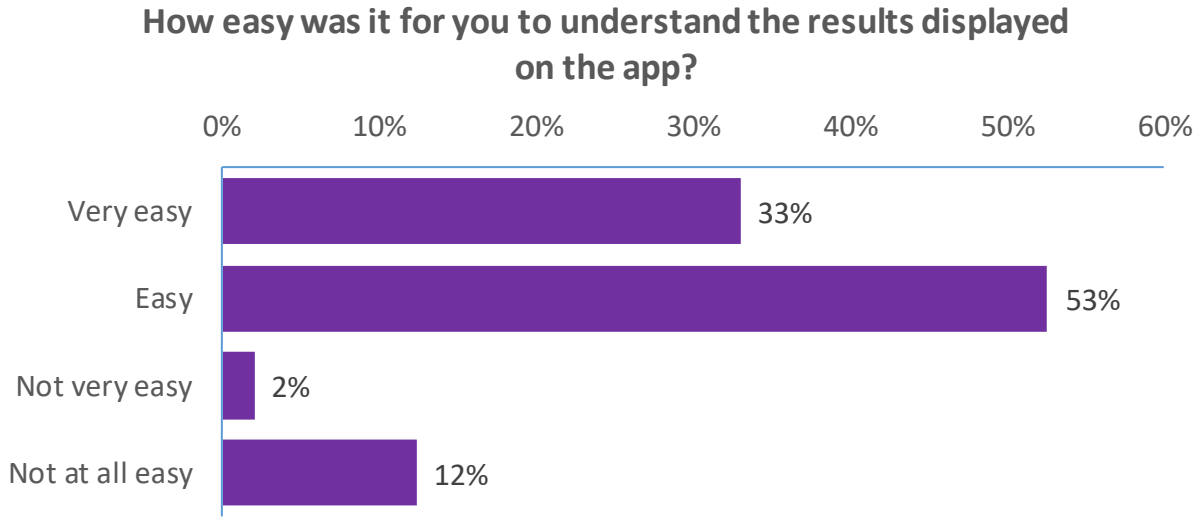
once a day. All of the participants in the first focus group were using the app to check their heart rate at least twice a day. They received a reminder if they did not remember to do so, which was helpful.

87% (n=332) of survey respondents said that it was ‘very easy’ or ‘easy’ to remember to use the Fibricheck app to monitor their heart rate.



Eight of the patients who had gone through the complete pathway said it was ‘very easy’ to remember to use the FibriCheck app while 5 said it was ‘easy’ and 1 person said it was ‘not very easy’.

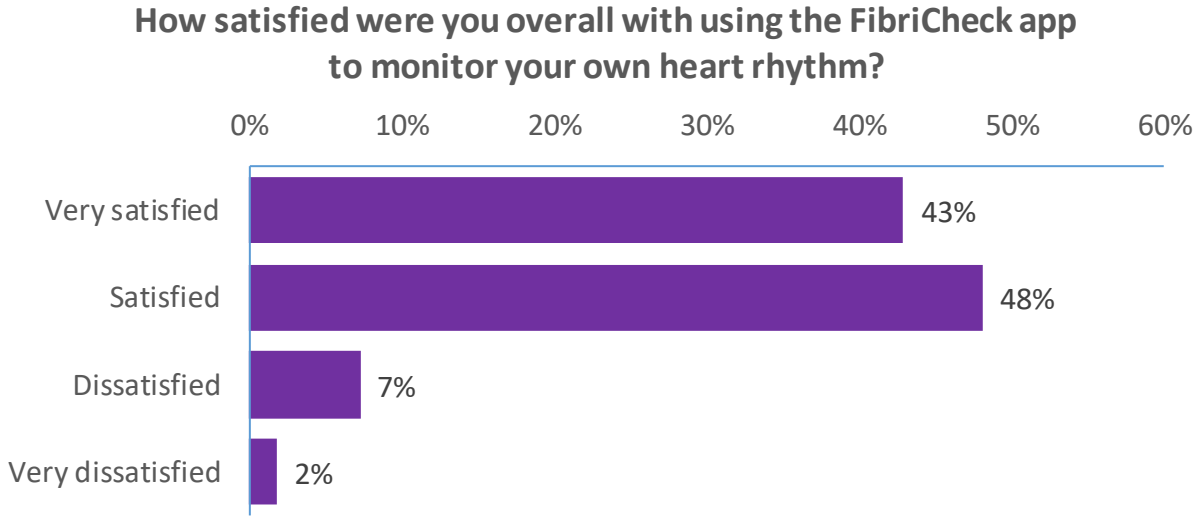
A third (33%, n=128) of respondents said that it was ‘very easy’ to understand the results displayed on the app while a further half (53%, n=204) said it was ‘easy’. However, 12% (n=48) said that it was ‘not at all easy and 2% (n=8) that it was ‘not very easy’.



Two of the survey respondents who had gone through the complete pathway said it was ‘very easy’ to understand the results while 6 said it was ‘easy’ and 5 said it was ‘not very easy’.

The reasons for respondents saying that it was not easy to understand the results were that the readings were very technical and not very informative, that it was unclear whether the readings were good or bad, or that the readings seemed to be different to the heart rate registered on a respondent’s blood pressure monitor.

The majority of survey respondents were satisfied overall with using the FibriCheck app to monitor their own heart rhythm, with 43% (n=166) being 'very satisfied' and nearly half (n=186) being 'satisfied'. However, 9% (n=35) said they were dissatisfied.



Feedback on FibriCheck app

All of the survey respondents who had gone through the complete pathway were satisfied overall with using the FibriCheck app to monitor their own heart rhythm, with 7 being 'very satisfied' and 6 being 'satisfied'.

180 survey respondents provided a comment about why they were satisfied with the FibriCheck app. Nearly half (47%, n=84) of these comments were that the app was easy or simple to use.

> *"Very easy to use. Very pleased to have been able to use this app to monitor my heart rhythm; I was quite reassured. An excellent accessible system."*
>
> *"The app was very easy to use and reminded me to take the readings. Both my parents have AF so it was good to be part of this study.*

Nearly a quarter (23%, n=42) of the comments highlighted that the checks had provided reassurance to the respondents.

> *"Very reassuring . Seeing the print out was impressive. It showed my heart beat as normal even when inside my chest it felt irregular."*
>
> *"It was easy to use and at the end of the week I felt reassured that everything was in the normal range."*
>
> *"I had recently found out my mother has an irregular heartbeat. As the test showed me I have a slight risk I will discuss the results with my doctor in the future."*

16% (n=29) of the comments were that the checks are a good idea.

> *"Any new technology which can determine if I've got a condition has to be good."*
>
> *"With very little effort on my part I get to check an aspect of my health (before it's too late) that would otherwise remain unknown. Thank you for the opportunity."*

16% (n=28) of the comments made were that the results and advice were clear.

> *"Ease of use and could see the result as it was happening, amazing technology."*
>
> *"I found the app easy to use and to understand the readings, but the written report at the end was a bit harder to understand."*

11% (n=19) of comments said that respondents had normal readings. However, another 6% (n=11) of the comments were that respondents wanted to have more information or follow up about any abnormal readings that occurred.

> *"It was good to know that I did not suffer from the heart problem the monitoring was designed to check."*
>
> *"I discovered I had an abnormality however it would be very helpful if there was some communication after the results from WSH to confirm if action is or is not required."*
>
> *"Brilliant way to measure heart rhythm. Slightly unnerved when many of the readings said ''irregular' then at end told nothing to worry about. I decided not to worry about it. Hmmm was that the right decision?"*

A number of reasons were given why respondents were dissatisfied with the app (43 people provided a comment).

Twelve respondents said they had difficulties in getting the app up and running or problems in using it.

> *"Because I was unable to get the app to work and was unable to find what was wrong."*

Seven respondents said they received no feedback about the results or the app did not really tell the respondent if their heart was OK. One of these said they had one reading that indicated an unusual rhythm but did not hear anything about this. Another said that during the one time when their heart was going a bit haywire the reading wouldn't register.

> *"Who follows it up? The WSH doesn't get the data and my GP knows nothing about it. I don't have AF but if I did, who would know?"*

Seven respondents said that the FibriCheck licence expired too soon and that more time was needed. For one person, the app timescale expired after one use. By the time another had confirmed it was not a scam they only had one day's use before it was stopped. One person said that by the time they felt confident in using the app it was the end of the trial and they would have liked to have used it for another week. Two people said that they sometimes get symptoms, but none had occurred during the week of using the app.

> *"I would have preferred to do it for longer. I occasionally get palpitations but of course not in the week I was doing the test."*

Six respondents thought that the app would cost them money after one week. This includes one respondent who thought that this was a marketing tool and money would be

sought and another who was told that at the end of the trials, if they wanted to carry on they would have to pay.

> *"Life was a bit hectic here when I was doing this and I thought it was going to last longer than a week. Must have missed that the trial was only for 1 week and now I cannot do it any more for free."*

Other reasons provided were as follows:

- It is hugely dependent on the phone used and its layout.
- Not being used to using apps on the mobile (2 respondents).
- Limited availability of the internet.
- Inadequate information provided about the reason for the test.
- Lack of advice about taking a reading.
- The phone became too hot quickly and the respondent burnt their finger.

Several focus group participants wondered whether a week using the app was long enough to pick up AF when for some people the irregular heartbeats happen intermittently.

Survey respondents were asked whether there was anything else that they would like to say about the FibriCheck app. Just over half (n=58) of the 110 comments made were that the app is a good idea, easy to use and useful, replicating comments made under earlier questions.

16 people commented about the cost of the app: that it should be free to use after the pilot; that they did not want to pay to use it after the pilot; or that it was too expensive.

> *"It would be great if this was permanently available as a free app via the NHS as it would probably help early detection of issues, before they became severe."*

Eight respondents said that the app should be available for a longer period of time, and 3 said it should be available to everyone.

> *"Wanted it to be more than a short experience. Feel use of tool gives confidence in managing one's own health and heart."*

Four people mentioned issues with using the app: it not recording an intermittent heart issue; having the fingerprint sensor under an old screen protector made it difficult to get readings; problems getting satisfactory readings due to poor circulation in the respondent's hands; and the app did not always register when the respondent's finger was over the camera.

Three respondents suggested that the results from the app should be sent to their GP and/or monitored by a health professional. Two others said that using the app was helpful as the results can be discussed with their GP.

> *"Needs to be checked more regularly especially when an irregularity is or has happened. While interesting and possibly valuable, unless it was being regularly monitored by professionals, I don't see much use for it."*

Three respondents suggested that providing help or support is needed for some people, e.g. via a phone number to ring.

> *"I told several friends (70+) about the trial i was doing and several of them said they would not have taken part as the "technology" was too complicated. I tried telling them it was actually very easy to do but they were put off by the idea of having to download apps. One didn't know where the camera was on her phone. I'm not sure that many women in my age group would respond to a text invitation. Most would require personal help."*

The other comments made were as follows:

- It would be useful for more user profile data to be included.
- The reminders to do it could have been sent at the same time of day and earlier as they seemed to come at random times.
- It is a good app but the Apple Watch app is easier to use.
- Although it is a very good app, it does not cover all heart complaints.
- Some of one respondent's friends thought it was a scam.

Virtual consultation with the cardiology nurse

All of the survey respondents who had gone through the complete pathway felt that the virtual conversation with a nurse before they were sent the Zio XT biosensor patch was useful, with 13 saying it was 'very useful' and 2 saying it was 'useful'. All of the focus group participants had had a phone conversation with the cardiology nurse who was described as very helpful. The participants in the first focus group sad that the contact with the cardiology nurse was very helpful as he was patient, reassuring and very clear with his instructions.

> *"[Nurse] gave you a chance to ask any questions, too. I mean, he didn't hurry you in any way at all. He was really good really good."*

Five out of the six participants in the first focus group were happy to have the consultation with the cardiology nurse by phone. Both participants in the second focus group accepted having a phone or virtual consultation as (since Covid) this is how they usually have contact with their GP, even though they would prefer to see someone in-person.

Using the Zio XT biosensor patch

Most of the survey respondents who had gone through the complete pathway said it was easy to apply the biosensor patch, with 4 saying it was 'very easy' and 9 saying it was 'easy'. However, 2 said that it was 'not very easy'.

One person in the first focus group would have preferred to have gone to a clinic to have the monitor fitted in-person, but said that the nurse was very helpful in talking them through the whole process so they did not have any problems fitting the monitor.

> *"Initially, I would have preferred to go in to them have it put on me, but that was before I tried. And did it myself and [nurse] I found brilliant, very, very helpful, and just talked through it. So it wasn't a problem."*

Several focus group participants would have preferred a consultation via FaceTime as this would have enabled the nurse to see what they were doing while fitting the monitor and be able to demonstrate what to do. One also said that they were hard of hearing so that being able to see someone on a FaceTime call would have made it easier to hear and understand what was being said.

> *"You can hear better if you're facing somebody and looking at them. I much prefer that."*

However, one participant did not know how to FaceTime so preferred a phone call.

Two focus group participants had got a friend or relative to help them put the monitor on.

The follow up phone call from the nurse a few days after the monitor was fitted was felt to have been useful reassurance that all was well.

Several participants in the first focus group suggested that it would be helpful to have some information about the monitor in terms of what it is monitoring, what sort of results might arise and what will happen next.

> *"I think the thing maybe [nurse] should be thinking about is that we're quite elderly, most of us are, and maybe not quite, quite up to date with all the technology. So it takes a bit longer for it to sink in."*

All of the survey respondents said it was easy to send the biosensor patch back, with 10 saying it was 'very easy' and 5 saying it was 'easy'. Sending the monitor back was also very straightforward for everyone in both focus groups.

When asked how long it took to hear back about the results after sending the patch back, 2 survey respondents said it took less time than expected, 8 that it was about the length of time they had expected and 5 that it took longer than expected.

Focus group participants had different experiences of being contacted after sending the monitor back. One patient said that they got a letter with information about the results, saying that they were at high risk and providing a list of medication they should be taking. Another received a letter saying they could have AF and that their GP would support them (they are now on an anti-coagulant). Some participants remembered receiving a letter but others did not remember getting a letter but remembered receiving a phone call from the nurse.

One group participant was phoned up and given an appointment for a series of further tests, and is now waiting for a heart valve replacement: detection was possible through the use of the app (rather than the monitor) picking up abnormalities that were not linked to AF but that would not have been picked up without them taking part in the pilot.

> *"The screening was sort of a godsend in that sense… so I'm really grateful for being picked up."*

Another was phoned by the cardiology nurse within a week of sending the Zio XT patch back and given an appointment with the cardiologist very soon afterwards.

"I knew it wasn't nearly very good news about it. Within a week I had a pacemaker. It was likely like you they picked something up."

One patient said that it took slightly longer than they had expected before they heard back about the results. Another had phoned up after three weeks when they had not heard anything so got the results then, followed later by a letter.

Several focus group participants said they received a printout of the readings from the monitor, and although they did not understand them the results were explained to them.

"I don't particularly know what I'm looking for, you know, I'm not a medical expert, so I'm not really sure what I'm looking for. Personally speaking, I wasn't entirely happy with my results, what they were, but it was explained to me properly."

Two participants said that the monitor had not picked up any arrhythmia for them, which is concerning as they are not sure whether the app picked up arrhythmia but the arrhythmia were not present while wearing the monitor, or whether the app was not accurate.

"I wonder how accurate [the app] is. Whether it picked something up that wasn't there. So now I'm in a quandary you see, was what came up on the app an episode and I just didn't have one when I got the monitor or isn't it very reliable?"

All but one of the survey respondents who had gone through the complete pathway were satisfied overall with using the Zio XT biosensor patch, with 5 being 'very satisfied' and 8 being 'satisfied'. Just 1 patient said they were dissatisfied, saying that it was difficult to keep it attached to their chest and that the adhesive caused irritation.

One of the survey respondents who was satisfied overall said that the patch had come unstuck once and 3 others said it was difficult to keep it on or dry while showering. However, 4 patients said it was easy to use and wear and another said it was very comfortable to wear and more resistant to water than they had thought. The other comments made are as follows.

"It was another way in which my health has been monitored and with all the other stuff in my life one less to worry about."

"The conversation I had with the charge nurse was very informative and reassuring. They didn't find a problem of Atrial fibrillation but recognised a less serious problem with ectopic heart beat. And this was explained to me."

"It was a very good process and piece of equipment which did not disrupt daily life. My wife had to help me fit the device however and also when taking it off. The fitting and taking off however were not difficult overall."

"It was a clever piece of technology."

"I am glad I took part in the trial and can see this being very useful diagnostic instrument. I didn't have a problem wearing it but I can see it could cause a problem for overweight people to be able to keep it in place for 14 days particularly if weather is hot."

All of the participants in both focus groups had problems with showering or bathing while wearing the monitor and trying to keep it dry. One person suggested that some guidance about what to do with the monitor while showering would have been useful.

> *"It was just trying to keep it dry. Try and have to shower was very difficult. I mean, I didn't know whether we could have covered it. You know, something? I wasn't sure. So I didn't because I didn't want to interfere with it too much. But maybe it's just some guidance about what you can do with when you're showering or something."*

The monitor had fallen off 1 participant a day early, but most of the other participants said that the monitor stuck on well, and stayed stuck on. Two had difficulties in getting the monitor off at the end due to the adhesive strength.

> *"They were pretty well stuck on, it was a job to get it off."*

Three people said they had a very red and/or sore area of skin after taking off the monitor, including one person who suffers from eczema.

One participant in the second focus group mentioned that they found it difficult to write notes in the book when something happened that made them breathe more heavily, especially when they were out of the house: they had to remember what they had been doing and at what time when they got back in order to write this in the book. They suggested that being able to talk to or write notes on an app on their phone, or press a button on their phone, would have been useful as they could record what was happening immediately.

> *"It was worth doing something on the app as I tended to carry the phone, it'd be easier. Maybe there's a list of activities and you can tick which one you're doing."*

Cardiology consultant follow up

Six survey respondents said that they were invited to attend a virtual consultation with a cardiology consultant after using the Zio XT biosensor patch. Three of these patients said they were happy to have a virtual consultation, 1 said they did not really have any preference and 2 would have preferred an in-person consultation.

Other comments

When asked if there was anything else respondents to the full pathway survey would like to say about the AF and heart rhythm checks scheme, 6 comments were made.

> *"This seems a great way to get an early indication of people with possible heart/stroke problems due to clots. It will save many lives."*

> *"It was very useful to have a face to face meeting with the cardiologist after taking part in the trial."*

> *"I think it is a very good check and could save many lives."*

> *"Glad to have the patch, otherwise would not have been aware that I had AF."*

> *"Think it could be a very useful tool for the future."*

"I think the whole study was very positive. I spoke to a designated heart technician or Nurse about my results. My results showed some ectopic heart beats but no atrial fibrillation."

"I was told that the monitor had not picked up any atrial fibrillation but to date I have not had a written report stating this fact and why this was the outcome based upon the results reviewed. Also I would like to know what other defects if any were recorded by the monitor."

For four focus group participants, the actual outcome of the pilot was a success since otherwise they would not have been diagnosed with their condition.

"Because if it hadn't been for that nothing would have happened."

Almost all of the participants in both groups said that any testing or preventative pilot such as this one is a good idea as it could save lives.

"Early checks are always useful to have, so I think I think the whole thing was the right idea."

Several focus group participants were in favour of technology that is well designed, is straightforward and can identify an issue. However, they recognised that not all older people are as confident with or as willing to use technology.

"I think it's a very good thing. When you're looking to find out if people have an issue, which is what you would do in effect. It's not invasive. It's not horrendously uncomfortable… I love technology, and I don't hate something that was very well constructed. It didn't crash or have silly things you had to do to try to get anywhere, it's straightforward."

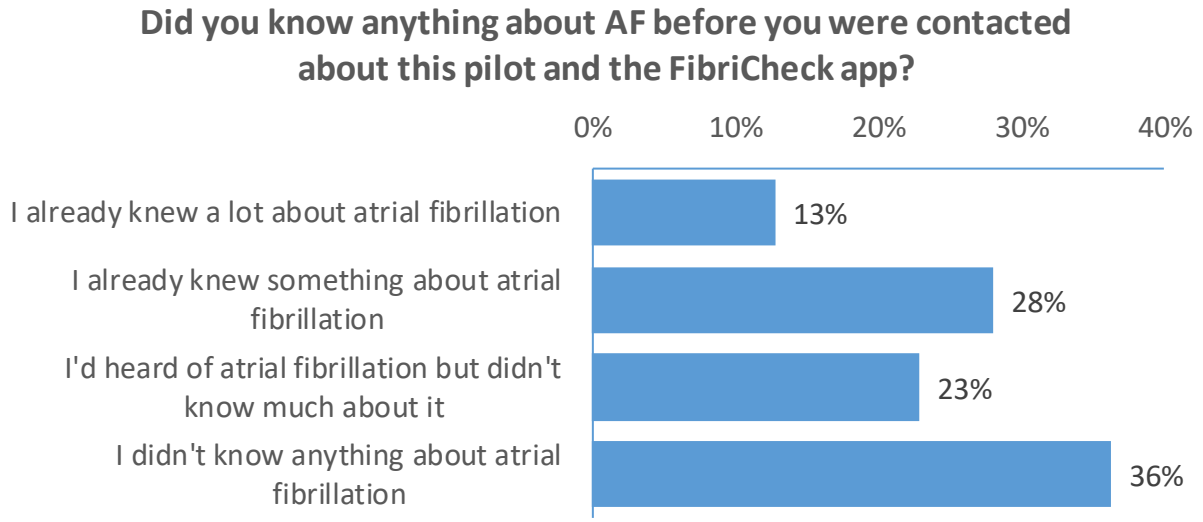
Patients in the second focus group asked whether the testing would be repeated as they could see its value.

Non-responders to the invite

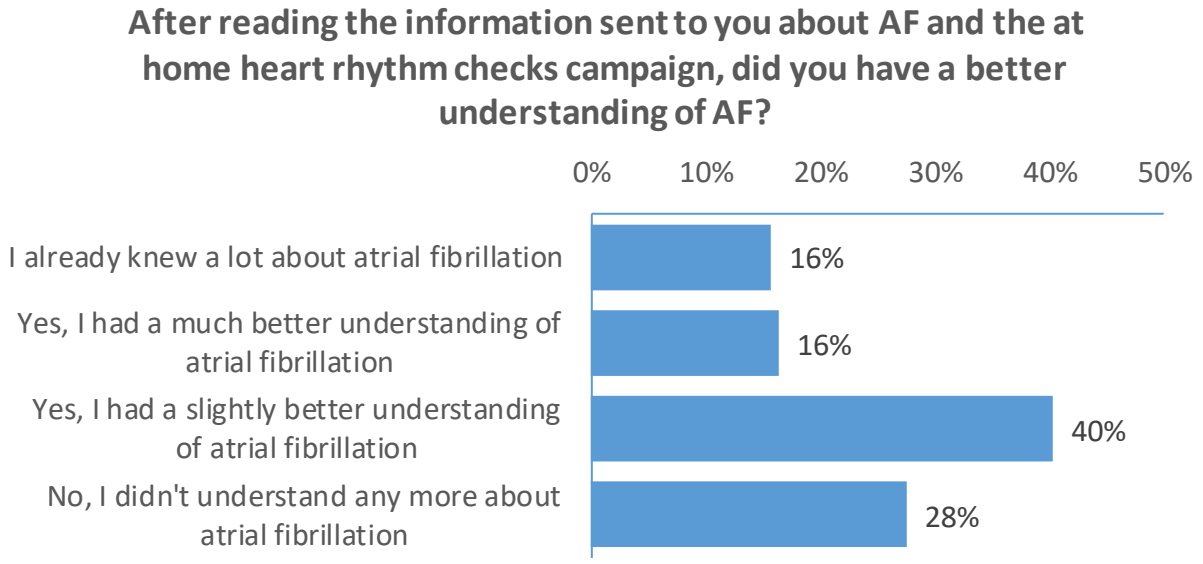
All those who had not responded to the initial text invite were asked to complete an online survey, and there were 532 responses in total.

Knowledge about Atrial Fibrillation

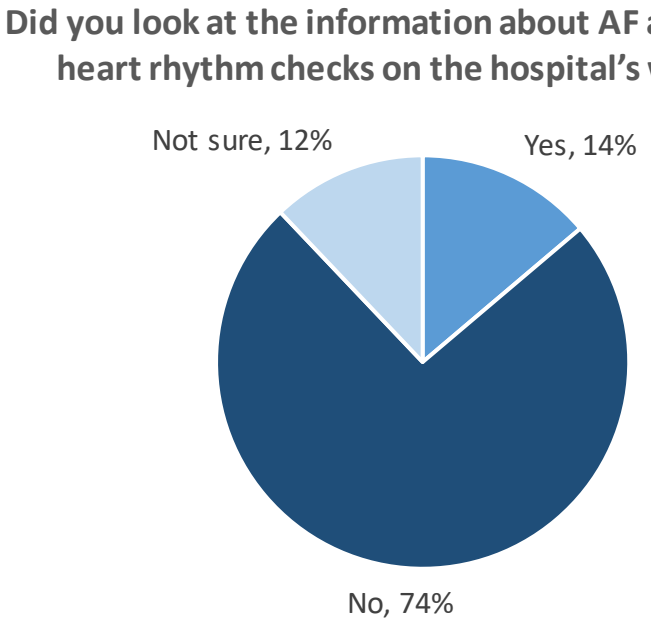
When asked whether they know anything about AF before they were contacted about the pilot, 13% (n=62) said they already knew a lot about AF and 28% (n=136) said they already knew something about AF. However, 59% (n=287) said that they did not know much or anything about AF prior to being contacted.



Respondents were asked whether they had a better understanding of AF after reading the information sent about AF and the at home heart rhythm checks campaign, and 40% (n=123) of those providing a response said that they had a slightly better understanding of AF while 16% (n=50) had a much better understanding.

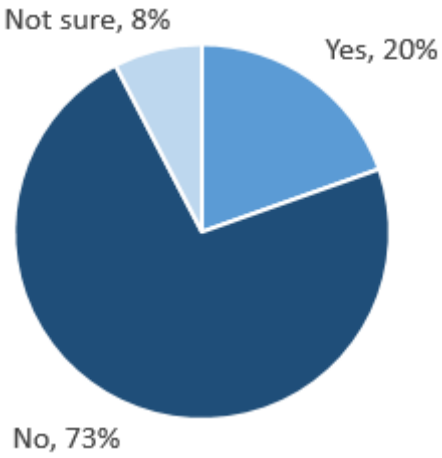


Respondents were asked whether they had looked at the information about AF and at home heart rhythm checks on the hospital's website - https://www.wsh.nhs.uk/Services-A-Z/Cardiology/Atrial-fibrillation.aspx?letter=A. Only 14% (n=64) said that they had.

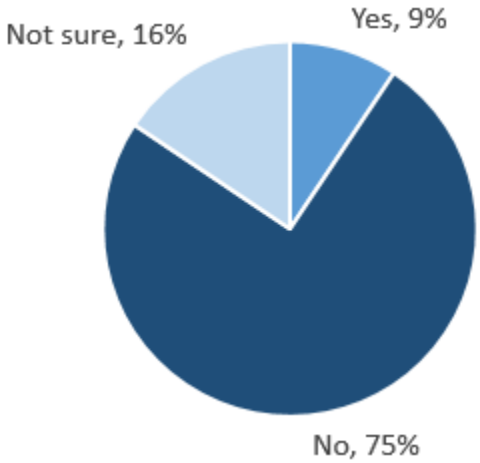


Respondents saying that they did not know much or anything about AF prior to being contacted were slightly less likely to say they had looked at the information about AF on the website and slightly more likely to say that they were not sure if they had done so.

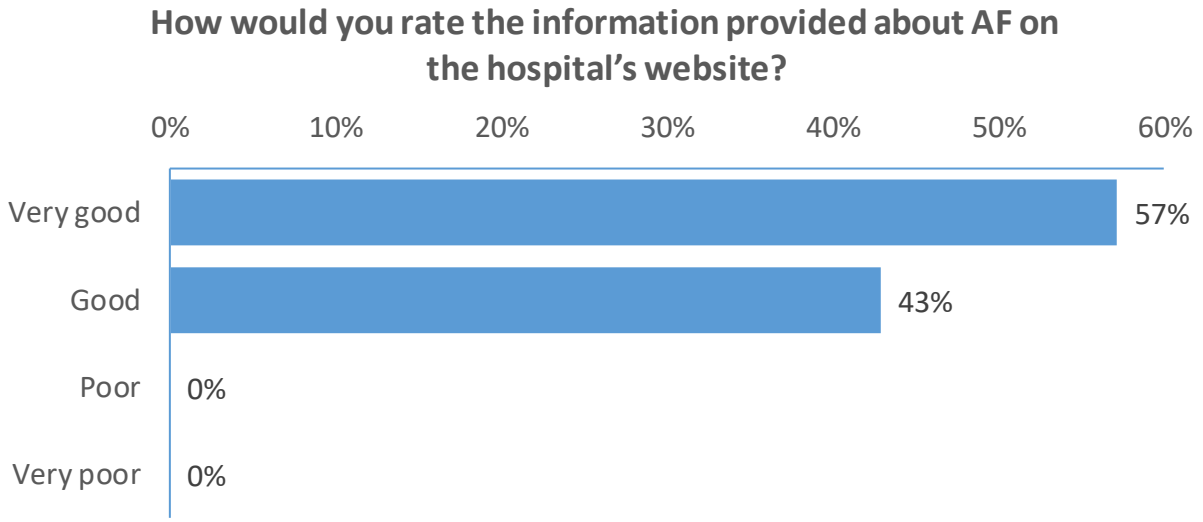
Respondents knowing a lot/something



Respondents knowing not much/nothing



Everyone who rated the information provided about AF on the hospital's website (n=35) rated it as 'very good' or 'good'.



74 respondents made a suggestion about other information that might have been useful to them in deciding whether or not to download the FibriCheck app.

11 of these comments were that there was no way of asking for help if people were having difficulty in registering or accessing FibriCheck, with another 3 being that they would need to ask a member of the family to help them.

> *"Did try think did get app but not let me register no one I knew heard about it so unable to get help show me what doing so gave up and had forgotten about it until just sent this."*

Ten of the comments said that the information/way of accessing the app should have been available via email, computer or other method.

> *"I would have liked to have known sooner that I couldn't take part because of technology. I'm sure there are many elderly folk without smart phones. Why could this not have been accessible online? I would have been able to take part if it were so."*

Eight of the comments suggested having a letter or phone call about the pilot.

> *"Maybe something coming in the post with clear instructions how to download the app as I didn't understand how to do it."*

> *"It should be sent to this phone number or sent hard copy details and then we can participate because we will have the details. Also messages left no one got back to me."*

Five of the suggestions were to have a way of confirming the text's validity or the fact that it was not a scam.

> *"In order to establish if this was a scam I telephoned my GP surgery who after speaking to the Practice Manager advised me to delete the message as they were unaware of this research."*

Thirty of the comments related to a specific piece of information respondents would have liked. Ten comments related to the provision of information about how the app works or the type of phone it can work on, what would be involved or simple technical instructions about how to download the app/ scan the code.

> *"To explain what was involved and how it would work."*
>
> *"Simple instructions on how to download etc."*
>
> *"It should have informed me of how much time i would spend daily doing the trial and what time of the day i would have to be prepared to do it, due to the fact that i do work long hours as a truck driver."*

Six comments related to why the respondent had been chosen for the pilot or whether the checks would be useful for someone with their specific condition. Several people also asked whether the feedback would have been beneficial to them and what would happen to the results.

> *"Is it helpful to a person like me with a bi ventricular pacemaker? I did ask this question but did not receive a reply."*
>
> *"First more information about my own specific heart situation. None was forthcoming. Then elaboration as to how the offer may or may not help me specifically- but generalised data."*
>
> *"Why was I selected to take part? What would have been the benefits of atrial fibrillation can stop/start.? What would have been the preventative implications of the results?"*

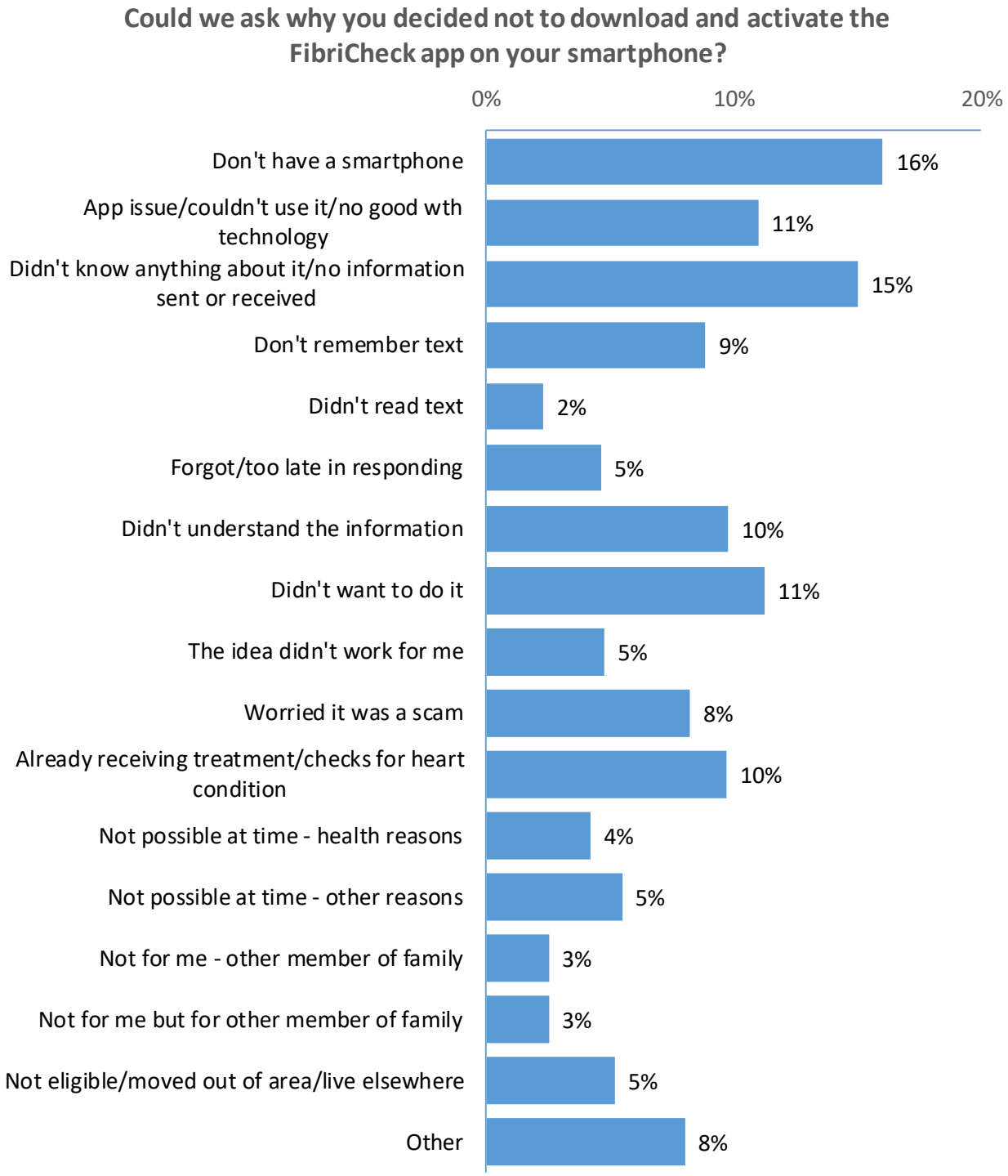
Three comments suggested that stating the name of the person being invited would be helpful.

Four further comments were made, suggesting:

- Inclusion of advice on existing cardiac problems.
- Information on who is funding the pilot (e.g. *"some big pharma corporation?")*
- It would be nice to receive information on FibriCheck.
- Information about AF and the effects of medication.

Reasons for not taking up the offer

The survey asked respondents why they decided not to download and activate the FibriCheck app on their smartphone and a range of responses were given within the 473 comments made.



The first broad theme of the comments was around technological issues: 16% (n=76) said that they do not have a smartphone and 11% (n=52) said they could not use or download the app or were no good with technology.

> *"I didn't know anything about it and I'm not very tech minded so was worried about doing this but I wish I had."*

"I would have liked to have known sooner that I couldn't take part because of technology. I'm sure there are many elderly folk without smart phones. Why could this not have been accessible online? I would have been able to take part if it were so."

11% (n=52) said that they just did not want to take up the offer and 5% (n=24) that the idea did not work for them.

The second broad theme was around the information not being received: 15% (n=71) said that they did not know anything about the pilot or had received/been sent no information about it. Another 9% (n=43) did not remember a text and 2% (n=10) did not read it.

"Not received anything about this, no messages sent."

"I don't recall receiving a request to take part in the trial."

"Not aware this was sitting in my phone until recently."

5% (n=24) of respondents said they forgot to respond or were too late in responding to the text to activate the licence.

"I was very disappointed I didn't take part in this. I was away at the time I received the text, by the time I was back it had expired. I emailed about this to see if I could still take part."

"As I was told not to contact my GP or WSH I thought the email was a scam. Once I knew it was genuine I was too late to join in _ or I would have."

10% (n=47) said that they did not understand the information.

8% (n=38) were concerned that the text was a scam.

"I did not read the information. I initially thought it was a scam. With better preparation I probably would have participated."

"I thought it was a scam because it stated that I was not to contact the hospital or my GP. I also spoke to a friend who had received the same text and she was of the same opinion. Also I didn't want to pay for it."

Other comments related to one specific point, including 10% (n=47) where respondents said they did not take up the offer as they were already receiving treatment and/or checks for a heart condition, so the checks were not needed.

"Have just undergone an atrial fibrillation ablation at the Royal Papworth Hospital in Cambridge."

"Because of ongoing medical issues I already have regular check ups

4% (n=19) said that they had not been able to sign up at that time due to other health conditions with another 5% (n=24) giving other reasons (e.g. being away) for not taking it up.

"Sorry, it was a very busy week my husband had multiple doctors appointments and my daughter has special needs and demands a lot of attention sometimes."

"I was very disappointed I didn't take part in this. I was away at the time I received the text, by the time I was back it had expired. I emailed about this to see if I could still take part."

3% (n=14) highlighted that the phone number the text was sent to was either shared or the text was intended for another member of the family.

"I share a phone with my husband and we did not know who the information was directed at. He assumed it was for him as I had already been diagnosed. I couldn't find any way to contact you to clarify."

5% (n=24) said they were not eligible, mainly as they had moved out of the area.

"I had moved out of the area and therefore would no longer have been eligible to take part."

3% (n=14) of respondents said that the pilot was not suitable or that the checks were not relevant for them.

"I have not got a heart problem. I contacted my doctor and they did not know why you had sent me the information and told me to ignore it! I did worry as you had contacted me for no reason."

"Person it applied to has severe learning difficulties and cannot take part without huge support which is just not available."

1% (n=5) said they thought there would be a cost to using the app.

"I thought if I started I would automatically have to continue and pay. I now wish I had read the information provided, and taken part."

The other comments are repeated below verbatim:

"I filled in the form both online and posted the form off to take part but heard nothing more."

"The reason I did not take part was when I phoned I was told I did not qualify for this otherwise I would have."

"I did download it but deleted it. It was some months ago. As I recall it was asking for information already known to the nhs so I saw no reason to provide this. I am not confident where this information would end up if I were to enter it so do not wish to take part. Also I do not want such remote medical care."

"I felt that I could check my own heart rate and rhythm."

"I have a smart watch that checks every day."

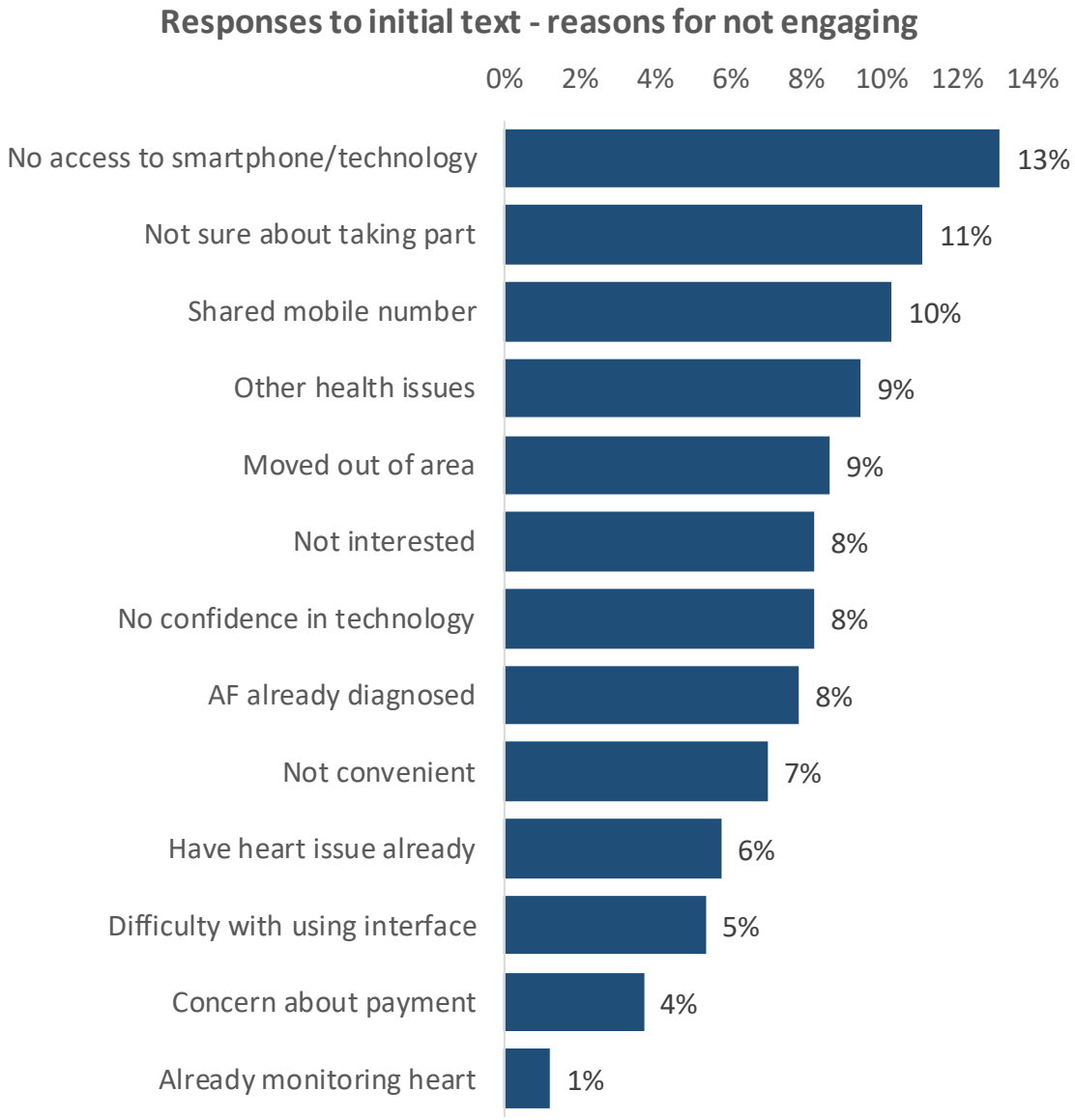
"I do not wish to participate in this - it is too much like Big Brother."

"I'm not interested in down loading I think this is lazy research and gives a weighted conclusion, research at a live clinic would be more effective and thorough. Tick box medical care is pandering to accountants and management not medical practitioners."

"I work full-time in Cambridge so unable to get to WSH for appts."

"I wasn't sure my contribution would benefit the research."

People receiving the initial text invite were able to provide a comment and 243 did so. The main reasons for not engaging with the offer were very similar to the survey of non-responders, with the three most common ones being that: they did not have access to a smartphone/ technology; they were not sure about taking part; and the mobile number was shared.



Any other comments

101 other comments were received when respondents were asked if they had anything else to say about the pilot. 52% (n=53) were that respondents would like to sign up now if the opportunity is still available while another 14% (n=14) said that they would have signed up for it if they had seen/received the information.

"I would like to take part in future - now I have confidence that it is a bona fide scheme."

"Receiving the invite would have helped as I didn't know anything about this and would have joined. Please send info again if still an option."

12% (n=12) of comments were that respondents would have liked to participate but were not able to do so, either due to technology issues or other things going on.

"I am sure it's a worthwhile scheme, Just not able to do it at that time."

"Very good scheme but not everyone has smart phone, or can get the app, and if like me are not techno able."

26% (n=26) of comments were that the pilot is a good idea.

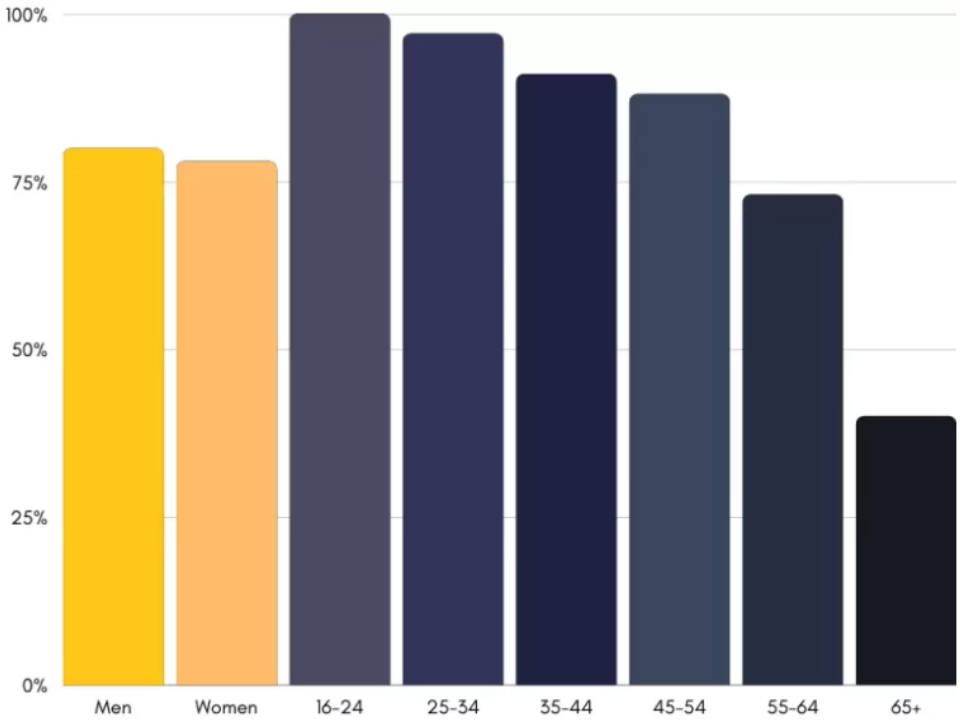
"It's a great idea for those people who are borderline and can monitor their heart rhythm to notice any changes and get treated faster."

Digital exclusion

Feedback from the non-responders survey shows that 16% said that they do not have a smartphone and 11% said they could not use or download the app or were no good with technology.

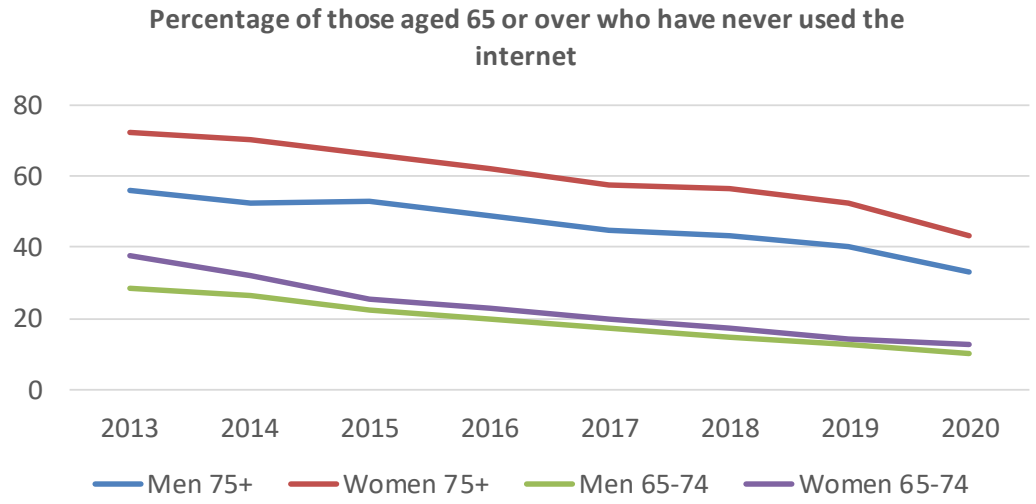
Data on smartphone ownership by age group is limited, but research by Statista estimates that around 40% of people in the UK aged 65+ own a smartphone.

Percentage of people by age group who own a smartphone (2021)



(Source is Statista's survey in the UK, 2021)

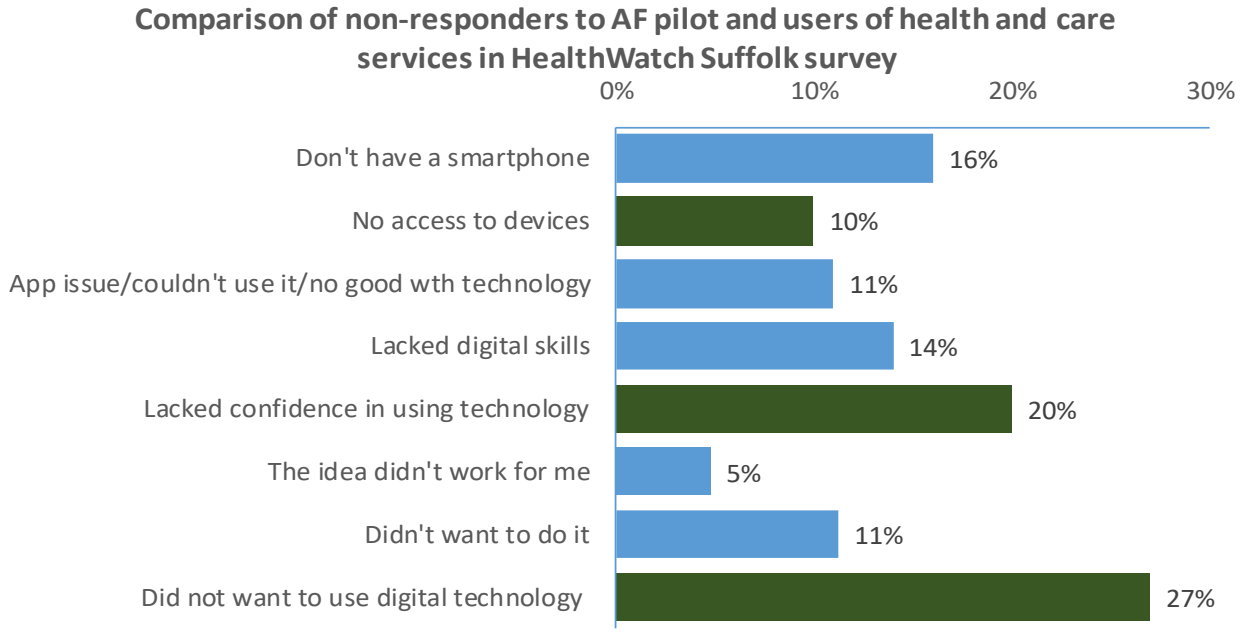
The ONS produces data on internet access which shows that in 2020 33.1% of men aged 75+ and 43.3% of women aged 75+ had never used the internet.



(Source is Office for National Statistics, April 2021)

Research by HealthWatch Suffolk (from a survey of 433 citizens in late 2020/early 2021, of whom 52% were aged 65+ and 82% were users of health and care services) found that 27% of the users of health and care services did not want to use digital technology while 20% said they lacked confidence in using technology, 14% said they lacked digital skills and 10% said they had no access to devices.

The findings from the HealthWatch survey can be compared to the findings from non-responders to the AF pilot, although the majority of the non-responders will be over 65 compared to just over half of the HealthWatch survey responders. The responses to the two surveys appear to be similar in terms of the proportion saying they do not have access to devices/smartphones or are not confident with technology. A slightly higher proportion of respondents to the HealthWatch survey appeared to state that they did not want to use digital technology.



Findings from professionals

Three interviews were held with professionals working for WSFT who were involved in the pilot: the Public Health consultant, the cardiology nurse and the cardiology consultant.

Data

Data sampling

The Public Health Team extracted the data required to identify groups at higher risk of having AF or who would benefit from anti-coagulation medication, using the CHA2DS2-VASc scoring system[8]. This was relatively easy due to the *"excellent"* IT system within West Suffolk.

The AF dashboard created by the Public Health Team was developed as part of their Population Health Management Programme since it was able to identify people in the population who were not yet diagnosed with AF and were not already on anticoagulants for some other reason. This provided a sampling frame to stratify by higher risk for AF at an individual level, with contact details for each person.

The data used came from patients known to the WSFT, i.e. mainly patients who had been in contact with the hospital but also including patients who had been in contact with the Trust's community services (e.g. community therapy, Occupational Therapy or Physiotherapy) and those registered with the general practice that is managed by the Trust.

> *"There's a clear potential selection bias there, isn't there? That the only people that we are communicating with have been in contact with the health service by definition, in the last, not very many years. They'll have had a pulse monitoring of some sort at some part… they'll have had obs (observations) taken because probably they've mentioned some symptomatology and you might have felt that pulse. So the likelihood of that being undiagnosed AF in that pool actually is rather less than in a general population who haven't necessarily had a secondary healthcare episode."*

This has limited the population cohort within the pilot as the data covers patients with a health issue attending the hospital or community services and not the full general population. However, the Trust will shortly have access to primary care patient data from all GPs in the area, so this would not be an issue if the pilot were to be run again.

The Public Health consultant identified some of the challenges of using the CHA2DS2-VASc scoring as the risk for an AF marker. Although there is no standardised instrument to identify the risk of AF, using something very simple like age over 65 plus hypertension or history of heart disease as the biggest risk factors may have sufficed.

> *"I understand the logic behind it, which was the ultimate so what? Because if they have got AF, then it's the risk of stroke that we're trying to minimize. But I think in the first instance, maximizing the chance of finding the people with AF feels more*

[8] The CHA2DS2-VASc score is used to assess the risk of stroke in people detected with AF.

important because CHA2DS2-VASc doesn't inform that... I just think maybe we're trying to be too nuanced about it, actually, although of course, then you end up with you can't stratify effectively if you use very broad categories."

Having a two-step filtering process – on age and macro cardiovascular disease factors first and then filtering on CHA2DS2-VASc scores afterwards – may have been acceptable.

Data quality issues

There were a small number of issues with the data quality of the electronic health records used where either an AF diagnosis had not been coded properly into the record (e.g. it was inserted only in a free text field or in a patient letter) or when AF had been diagnosed between taking the snapshot of the live data and contacting patients.

There were also a number of patients with inaccurate addresses who had moved out of the area: this issue would be resolved, however, once the primary care data is linked to the Hospital Trust records because the primary care data should be more up to date.

Another issue was that a proportion of the messages were sent to an unintended recipient in cases where either the phone number of adult children of elderly parents was recorded as the parent's actual number rather than as next of kin or where a number of older couples share a single mobile phone and therefore a single mobile phone number. This would not have been an issue if it had been possible to include an identifier in the message, but the system being used to send texts would not allow this.

"The upshot was that we would end up sending a generic invitation message to a mobile phone number, and Mr. and Mrs. Bloggs would essentially be on the end of it, not knowing which of the couple we were intending it for."

Communicating the heart rhythm checks pilot

The cardiology consultant felt that it was very helpful to have Public Health leading on the communications to patients as they are used to sending this kind of information about testing out to patients. A patient advocate involved in this phase was very good, and gave advice on communicating with elderly patients. The team was able to make small changes to the wording of communications and also adapt the method used.

"We learned a lot from what we sent out initially to patients and changing the wording a little bit, and also the method we used to send out to patients."

The pilot would have preferred to use the hospital communications team but they didn't have any resources at that time to help.

The role of identifying and communicating with the patients at higher risk involved writing the wording for text messages, identifying the methods to be used for sending the text messages and then managing the responses received and sending reminders to those who had not responded.

"Working out the exact wording of the text messages, obviously with the rest of the project team as well, and working out the methods for sending those messages and the pathway for how patients would flow through this potential pathway. And then managing our end of the data collection around who had responded, what their responses were, sending out reminder messages, and collating together the data."

The Public Health Team selected the subset of patients that had a mobile phone number attached to their record and the messaging service DrDoctor was used for the initial text messages. Texts contained a link stating that it was from West Suffolk Hospital with a link to information and to an online portal hosted by the DrDoctor service. This online portal allows the posing of a question for the recipient with 'yes', 'no' or 'unsure' options for responses. The 'unsure' response was not an option that the Public Health Team wanted, but it could not be removed. Recipients had to put in their date of birth to verify their identity, which proved to be a useful step to try to work out whether it was the right person responding or not.

Those responding 'yes' received an automatic text back with a link to the license-paid full version of the FibriCheck app. Those responding 'no' were not sent any further texts. Those responding 'unsure' were included in the reminder set of messages, unless they added a comment about why they were unsure and this comment meant that the pilot's methodology would be unsuitable (e.g. that they do not have access to a smartphone or they are very ill).

A reminder message was sent seven days after the initial message using DrDoctor with the 'yes', 'no' and 'unsure' options.

A possible issue arising from the automatic text with the link to 'yes' replies was that this arrived immediately but people were expecting to be sent a separate text with the link and more information rather than having this as part of the automated response.
"I think a lot of people didn't see it or didn't realize that this wasn't just a thank you for responding we'll be in touch type thing."

During a trial on the first 100 patients, a number of people were not sure whether or not the text was a genuine message, because the DrDoctor system appears on a phone just as a mobile number. The Public Health Team then placed the number on the hospital's website as a legitimate number that messages may come from.

A slightly different approach was tried for the second or third tranche of patients, whereby half got a text message from the NHS branded no reply texting service saying, "*you'll get a text message from this number in a few minutes so it's genuine"* and the other half were sent a letter explaining the project and saying the same thing. These were both followed up by a text from DrDoctor and then followed the initial process. Unfortunately, for reasons related to staff sickness and the length of time replies from each tranche was left "open", it is not possible to draw conclusions from the response rates to the different approaches. Additionally, this approach was unsustainable due to the laboriousness and *"immense faff"* involved, particularly with printing letters, putting them in envelopes and posting them.

Sending text messages via the NHS service was seen as a much more productive route, but as the Public Health Team did not have direct access to this system they were:

"having to then liaise with somebody else and essentially beg favours from people to try and get that done." However, if the text messages could have been sent from the NHS number, there might have been a higher uptake since patients would have considered it to be more legitimate.

Although the team looked at different ways to get the message out, other methods would have been time consuming and it was agreed that the activation rates were no better or worse than via text, so the additional resource required to facilitate this was not a viable option.

> *"So the easiest cheapest way we could do it was actually send a text message out and that did prove to be not brilliant, because patients would get this or their next of kin would get it because it's their number we had and so then there was a lot of a lot of questions about what we were doing."*

Therefore, sending texts from DrDoctor was the approach used for the majority of the pilot. This had the benefit of not being as labour-intensive as other options because of the automated message in response to a 'yes' reply.

An additional benefit is the data captured by DrDoctor could be downloaded for the Public Health Team to look at the responses and response rates in real time, and also look at the comments made by patients. This has provided some extra intelligence to look at whether recipients were the right ones or not from their date of birth and qualitative data from the 700 or so responses that had a comment attached to them. Around 75-80% of these comments were positive saying essentially, *"I have to take part, this sounds good".* (Just 3 negative comments were received.) A proportion of the comments explained why people were unsure, e.g. they were going on holiday, had moved out of the area or were not sure why they had been invited. Some of the comments detailed symptoms that patients were experiencing that they felt were relevant.

> *"The majority were very positive. Just expressing support for screening and new ways of working and grateful, I think, for a genuine interest in their health, just how it was perceived."*

Barriers for some people taking up the offer included not having access to smartphones, although this was a minority of people and appears to be lower than assumed given the age structure of this population. Although many (due to Covid) are now more familiar with using a smartphone or tablet, they may still struggle with just receiving a text message and assume it is a scam. Lack of confidence in using the technology was a barrier for a small number of people. There were several comments suggesting that people were worried about the money element, which may have been because they accessed the FibriCheck app directly (where it does ask for financial information) rather than clicking through the link, or they have misunderstood. A number of people were concerned that the text may have been a scam rather than a genuine offer.

The overall response rate from the over 10,000 patients contacted was 16%, which was seen as *"phenomenal"* for this kind of cold contacting.

> *"I'm really happy with that. Obviously, you know, it'd great if it was higher, I suppose. But, you know, I think that was higher than we'd expected."*

Around half of the patients who replied ‘yes’ to the text did not go onto sign up for the FibriCheck app, and it would be interesting to understand why this was so: it may be due to them missing the link in the automated reply text. There were also some issues with people thinking they needed a code to log into the FibriCheck app.

The final text sent to all patients, asking them to complete an online survey about their experience of the pilot, produced a number of responses. The majority of these said that the person had not received any information, although they were definitely sent a text so they probably either did not see the texts or had only partially read them and dismissed them. A few people said that they would have liked to have taken part if they had seen the text and asking to do so now. A couple of people said they thought it was a scam and a few said they had moved out of area.

Feedback on the pathway

FibriCheck app and reports

The FibriCheck reports were easy to read and easy to access and although they contained a lot of data, it was easy to see whether it had discovered any irregularities.

However, FibriCheck is not able to figure out whether an irregularity is caused by AF or whether it is an irregularity possibly caused by, for example, a heart blockage or ventricular ectopics. Out of the 36 Zio XT patches sent out, 10 people have been diagnosed with AF and there are 16 who mainly had SVTs or ectopics or pauses: it is still useful to pick up a heart issue even if it is not AF.

> *“One example is a gentleman who flagged up red on the FibriCheck but we couldn’t find any fibrillation on him, all we found was that… he was having some pauses but those pauses that we found in this gentleman were safe pauses, he was totally well, he was totally asymptomatic, but when you have pauses then you will have what the FibriCheck may perceive as irregularity.”*

Following up those identified with potential AF

Patients registering a red report on the FibriCheck dashboard were cross referenced against their hospital records to check they had not been diagnosed with AF already/in the interim. The cardiology nurse then made contact with them, introduced himself and explained what the project is for and what benefit patients could get from it. If they were happy to continue he offered to send them the Zio XT patch: no one declined the offer. The Zio XT patch was then sent to their address plus a blood pressure monitor machine. The nurse registered all of the patients’ details onto the Zio dashboard and after the patch was sent back, he got a notification that the results were available.

The cardiology nurse encountered a number of barriers when contacting patients, mainly that he could not get hold of them or it took several days to get hold of them after multiple phone calls at different times of the day. Ensuring a prompt contact with patients is important and sending a Zio XT patch before having spoken to a patient was not recommended.

One improvement made to the process was to have two phone conversations with patients, rather than trying to explain about the Zio XT patch before they had seen it. The nurse then phoned to tell patients that they were to be sent a Zio XT patch if they were happy with this, and then phoned again a few days later once they had received the patch to explain to them how to put it on.

> *"I think doing it that way made it better, engagement wise with the patient."*

For some (the later patients) the cardiology nurse had a follow up contact in the middle of the Zio XT patch period to ask them how they were getting on and whether they had found any issues.

Zio XT biosensor patches and reports

The cardiology nurse felt that the Zio XT patches are easy for patients to use even for those who are older (many are in their 70s and some in their 80s) which is an age range that may not use technology much or at all.

> *"Someone in that age, sometimes they're a little bit technology… they think, 'oh dear, what am I going to do?' but even still they were able to follow the instructions."*

The Zio XT patch is a good monitor for patients to use. It is much easier for patients to use than the Holter monitor as it just one patch to be applied, with just one contact point, whereas the Holter monitor uses three or four different leads and if one of them comes loose the quality of the reading can be adversely affected, especially if the patient does not realise that one has come loose.

The process of sending the Zio XT patch back was seen as being convenient for patients because it comes in a box which is already pre-stamped and just needs to be dropped off at the post box/office.

The information received from Zio was very good and the tracing was very good. The information is fairly easy to read through and analyse for someone with a background in cardiology.

> *"I've shown one of the reports to one of our physiologists in the hospital and she was actually quite impressed with it, comparing it with a 24 hour Holter [heart monitor] and the reports that we get from the usual 24 hour Holter."*

Once the Zio report was received, the cardiology nurse read through the reports, analysed the data and then rang the patients to explain all the results, reassure them and give them advice etc. Following this, he wrote a clinic letter for the GP and the official Zio report was uploaded to the patient's official hospital records also. Where necessary, the report was referred to the cardiology consultant: there were a few patients who needed further intervention.

> *"It's more to do with the clinical aspect so consultation with the patient and more or less reassuring them."*

Having a remote consultation

Remote monitoring as an approach was seen as being acceptable since the Zio XT patch produced very good quality readings and meant that the nurse was able to get in touch immediately, arrange blood tests and start them on medication. If this had had to go via the GP, it would have taken several days longer.

> *"[A] gentleman that I saw and he was going to go on holiday and I didn't want him to go on holiday without medication and if I was to run it past the GP then it's almost certain that he will go away without the medication so doing it in that way allowed me to actually prescribe him the medication that he required and now I feel happy that he's on holiday without fearing that he'll drop off with a stroke or something."*

The remote pilot has been beneficial for the patients as they have not had to come to the hospital. With the pilot being a remote service, asking patients to attend a hospital clinic would have been contrary to the idea of the pilot. While a remote service is convenient from the patient's point of view, as they do not need to leave home, it is not as ideal for clinicians.

> *"The remote [consultation] is more convenient for them but less ideal for myself, obviously the face to face one is the one ideal for the clinician but perhaps they will have more challenges or barriers from the patient's side."*

Although this pilot used a remote/virtual approach, a key success factor was having really good communications with patients, both in written format and also verbally.

> *"So pick up the phone, that is so important, because this is all meant to be virtual, which is fine but just because it's virtual it doesn't mean you can't speak to your patients. And patients do really, really benefit from that immediate feedback."*

Patients have really benefitted from the phone consultations which have enabled the reassurance of any concerns, explanation of certain aspects and answering their questions at the same time. This has also helped with patient engagement in the pilot.

> *"If have concerns, and there's no one to reassure, or explain things back at you immediately, then you're more likely to say no, to the project. Whereas actually, you're getting a phone conversation already, you feel that you're being taken care of by someone on the other end of the phone, that's really important, isn't it, if someone is looking after your health, especially after the last two to three years, you're more likely to engage, you're more likely to listen, you're more likely to take part and actually, as a result of this, you're more likely to be aware of what the project was about and continue, hopefully, to look after your health afterwards."*

The cardiology consultant felt that the remote consultations with patients by the nurse worked extremely well, although this may not be something that can be rolled out everywhere unless there are people with a similar role and "passion".

> *"It worked extremely well here, because [nurse] is amazing. He's passionate about Atrial Fibrillation, and he is really hard working but I'm not sure you can get a [nurse] in every other department in every other hospital to roll this out."*

The consultant felt that the cardiology nurse and his communication with the patients (getting in touch when they flagged red on FibriCheck, telling them the next steps, explaining about the Zio XT patch etc.) was key to any success that might come out of this project. However, this was possible as the numbers were not huge for the pilot and if the checks were to be offered on a bigger scale, then this activity would need to be done by a team of people rather than just one person.

Having a remote consultation meant that clinicians were unable to check that processes and instructions were being followed – for example putting the Zio XT patches on correctly.

> *"In an ideal setting, you would have your checklist or your guide and you wouldn't think, this should've been done, that should've been done, but speaking with them over the telephone, you don't know whether those are being done, whether they're actually making short cuts, including putting the Zio on, whether they're actually following the instructions."*

A face to face clinic might make it easier to ensure that the Zio XT patch is applied properly, although this was not a great problem for the 36 patients who were sent one. (And, in fact, the few that fell off were during the heatwave over the summer so probably due to people sweating.) During this project, the average wear time for the Zio XT patch was 13.1 days, the median wear time was 13.3 days and the minimum wear time was 8 days.

> *"Most of them, if not all, were able to put the Zio on properly. There was maybe just a couple whose Zios had fallen off, but we were still able to salvage it."*

Some patients would find it difficult to attend a hospital clinic, for example those who live alone and have transport issues.

Diagnosis of Atrial Fibrillation

The interviewees stated that the pilot has succeeded in identifying 10 new cases of AF who are now receiving treatment. Applying assumptions about the likelihood of a stroke in a given population indicates that for those 10 people, one stroke over the next two years has been prevented. Preventing one stroke case has significant associated human benefit as well as cost savings for the system (quoted by the Public Health consultant as being £80-£100k, which is more than the cost of the pilot).

Two patients out of the 10 identified as having AF were diagnosed with the condition but had no noticeable symptoms so would not have been identified via the traditional routes of showing symptoms, going to a GP and being referred to a cardiologist.

> *"So these patients are having symptoms but ignoring them at home and not going to see anyone. So that's quite interesting because we always assume that we're screening for asymptomatic people."*

> *"There's this one or two who were totally asymptomatic, they didn't even know they had irregular heart rhythm and so if we didn't have this trial, those two people that we found out of those 10, wouldn't have gone to their GP."*

The two cardiology professionals felt the pilot has certainly identified patients whose first presentation of symptoms is likely to have been a stroke, but the rates are not as high as they might have expected. It is possible that the Zio XT patch did not pick up symptoms during the 14 days when patients wore it as the symptoms can be intermittent. One area for investigation is why the Zio XT patches had a lower number of positive readings than the FibriCheck app.

One patient who was flagged red by FibriCheck but had started to become unwell and had a pace maker fitted before the Zio XT patch could be sent to them.

There were also a number of patients with arrythmias that the Zio monitor was able to pick up but who did not necessarily need treatment. One patient with tachy-brady syndrome was symptomatic of AF in feeling breathless and lightheaded, with episodes where their heart rate would go either very fast or very slow. The Zio monitor was able to discover this as an issue, rather than AF, so they could receive the correct medication and have a pace maker fitted. There were also several people where the Zio monitor found that they were having runs of ventricular tachycardia but as they were already on pre-existing medications they did not need treatment for AF.

The pilot has picked up a number of patients (who were likely to have been seen by the cardiovascular clinic in the future) who have benefitted from an earlier diagnosis of AF because of the pilot.

Part of the advice that was always provided to the patients who had a Zio patch fitted but were not diagnosed with AF was that even though AF was not identified, their risk for developing AF is still as high as it was before so they need to be vigilant about it: if they feel their symptoms have started becoming symptomatic, with breathlessness, palpitations etc., then they must get in touch with their GP. They were also encouraged to check their blood pressure with the blood pressure machine sent to them with the Zio XT patch.

Improving the pilot

It is important to collect data at the patient record level more consistently and to be very clear about who phone numbers belong to, although a workaround (which is probably simpler) is having a technology solution allowing identification of the message's target.

An important element to repeating the pilot would be having mass communications and publicity about it so that people are more aware. It took time for information about the pilot testing to be widely known (amongst both healthcare staff and also the wider population) so a communications strategy to tell staff in patient facing roles (e.g. on the switchboard) about the pilot would have helped, so that they were aware of it and could tell anyone who called that it was legitimate rather than a scam.

> *"We ended up sending out 10,000/10,500 [texts]. So I think people probably became aware of this is a thing and that it wasn't a scam and it was okay. But obviously, that takes time for that message to get through."*

> *"One of the things we didn't do is tell every single person in the hospital, this is what we were doing. So of course, when people are getting phone calls in switchboard or other areas, they may not have necessarily known about it."*

There are three *"tweaks"* to sending texts from DrDoctor that would improve the approach: include an identifier about which patient is being contacted; remove the 'unsure' option which was felt to be not at all helpful; and introduce a delay in sending the automated response text containing the link. It is also possible that to avoid people bypassing the link and downloading the FibriCheck app directly a separate activation code text would work better than the clickable link within the automated response.

Providing some information about the process within the reply text would have been helpful to avoid people thinking they needed a code to log into the FibriCheck app.

> *"Maybe rethinking the process of the licensing and making it as simple as possible. However, we can do something there because I think it's too many steps there and too much potential for confusion and yes, provision of information and explanation of the process."*

Another suggestion for the future would be to have the FibriCheck licence open for two weeks, both after the first text and also after the prompting text. This would allow people more time to download the licence and monitor their heart rhythms.

Sending a letter to patients registering as red on the FibriCheck dashboard but who did not respond to the nurse's phone calls might be helpful in the future for those who are difficult to contact.

Further analysis is needed to understand the profile of the 26 patients (out of the 36 who were sent a Zio XT patch) who despite being flagged as red by the FibriCheck app were not diagnosed with AF by the Zio XT patch. One reason might be that AF can come and go so the FibriCheck app picked it up whereas it may not have been present during the 12-14 days the Zio XT patch was being worn. (The patch can only be worn for 14 days as the battery life is 14 days and skin irritation can arise around the adhesive.)

One suggestion to consider would be whether it might be possible for people to continue using the FibriCheck app while wearing the Zio XT patch to compare whether both or just one is indicating AF symptoms. In the pilot, patients used the app and then the licence expired so they could not use it while wearing the Zio XT patch. However, using the two together might provide clarity about whether, over the same period of time, the Zio XT patch does not pick up AF whereas the FibriCheck app does.

> *"If the FibriCheck still flags up red and the Zio is actually monitoring and it doesn't pick up the AF then we know that the FibriCheck is actually picking up only the irregularities and not AF... one other vision that we may have had is that the FibriCheck has picked up the AF but it was just so unlucky that while they were wearing the Zio, the AF has not manifested itself."*

Value of the pilot

The pilot was seen as successful and very useful in identifying people with AF. If it was something that could be repeated (and perhaps if people were to have more awareness of it so those that declined at the beginning might now accept the offer) then it would be beneficial to run it again.

"I found that it was really good, it was really useful, it was really good. If we had a service like that, I feel it would be beneficial."

The Public Health consultant felt that there is a massive potential to use this kind of digital approach with an older population, despite the assumptions that it is not possible with people who are over 70 or over 80 and that they are likely to be digitally excluded. In fact, the response rate was very good.

"And that's even without having NHS branding on your messaging. Yes, you get a bit of pushback, but you get really, really good response rates with an offer that is maybe of dubious value to most people on the face of it… it was seven days of monitoring for a heart condition. You know, that's maybe a bit of an ask for some people, it depends whether health is top of their list or not."

This is a relatively simple, fairly automatable and scalable technology and the approach could be very valuable and used for a range of other settings or services.

"It could be an incredibly valuable tool to use in all sorts of IT settings, impact of care in particular and really helpful."

Although the pilot has taken time to get it up and running, as is the case when it is the first time of doing something, the Public Health consultant felt that it could be scaled up very quickly.

"The final 5,000 or so we did in over the space of a couple of months having, you know, it took a while to get going."

The Public Health consultant felt that the pilot demonstrated that it is acceptable to a significant proportion of the patient population. Repeating the testing would be very valuable and have a large potential return on investment since people can be asymptomatic or have symptoms that are intermittent.

"I think as a potential for the preventative approach that has got a huge potential return on investment, I think it's really valuable and it's the kind of intervention as well that could be repeated, you know, akin to a sort of a screening program because if people have paroxysmal AF or they go in and out of AF over time, doing a repeat sort of intervention would be entirely reasonable."

The cardiology nurse felt that the at home heart rhythm checks would be sustainable for the future to help identify AF more promptly. This is particularly important as there is an aging population where AF is very common but may not be identified until it has become more serious or been exacerbated, for example, by a chest infection.

"I'm pretty sure there are many that are AF out there who could be picked up quite quickly rather than going for the traditional way that they wait before the AF is bad enough because often, what I see in the hospital is, people may have gone into AF, they didn't know about it, they then get a chest infection for example, the chest infection then exacerbates the AF and then the heart goes too fast, they become completely unwell, they come into the hospital, they get treated for chest infection and then incidentally find that they are in atrial fibrillation but what if that didn't happen?"

The cardiology consultant suggested that rolling the at home heart rhythm checks out within the NHS will depend on the costs. During the pilot period, the yield has not been high enough to say definitively that it is a valuable return on investment. However, they can see a value in using the Zio XT patches for post stroke patients who currently are given a seven day event recorder which is not as good.

However, it is important to look at the full data from the pilot in terms of the number of people sent a text, the number downloading and using FibriCheck, the number registering as red (56), the number receiving Zio XT patches (36) and the number being diagnosed with AF (10).

References

Patel, A., Berdunov, V., Quayyum, Z., King, D., Knapp, M. and Wittenberg, R. (2020). Estimated societal costs of stroke in the UK based on a discrete event simulation, Age and Ageing, Volume 49, Issue 2, March 2020, Pages 270–276, https://doi.org/10.1093/ageing/afz162

Shih, J.H. & Jay, M.P. (2017). Pearson's chi-square test and rank correlation inferences for clustered data. Biometric Methodology, 73(3), 822-834. https://doi.org/10.1111/biom.12653

Appendix 1: Questionnaires

Survey of patients who downloaded the FibriCheck app

Did you know anything about atrial fibrillation before you were contacted about the checks and the FibriCheck app?

- ☐ I already knew a lot about atrial fibrillation
- ☐ I already knew something about atrial fibrillation
- ☐ I'd heard of atrial fibrillation but didn't know much about it
- ☐ I didn't know anything about atrial fibrillation

After reading the information sent to you about atrial fibrillation and the at home heart rhythm checks, did you have a better understanding of atrial fibrillation?

- ☐ Yes, I had a much better understanding of atrial fibrillation
- ☐ Yes, I had a slightly better understanding of atrial fibrillation
- ☐ No, I didn't understand any more about atrial fibrillation
- ☐ I already knew a lot about atrial fibrillation
- ☐ Other (please specify)

Did you look at the information about atrial fibrillation and the at home heart rhythm checks on the hospital's website? (https://www.wsh.nhs.uk/Services-A-Z/Cardiology/Atrial-fibrillation.aspx?letter=A)

- ☐ Yes
- ☐ No
- ☐ Not sure

[If Yes: how would you rate the information provided about atrial fibrillation on the hospital's website?

- ☐ Very good
- ☐ Good
- ☐ Poor
- ☐ Very poor

Is there anything that could be improved about the website or any other information that you would have found useful?]

Did you download and activate the FibriCheck app on your smartphone?

- ☐ Yes [continue]
- ☐ No [go to end]

How easy was it for you to register with the FibriCheck app and activate the free licence?

- ☐ Very easy
- ☐ Easy
- ☐ Not very easy
- ☐ Not at all easy

[If not easy: Why do you say this?
What would have made it easier?]

How easy was it for you to use the app to monitor your heart rhythm?

- Very easy
- Easy
- Not very easy
- Not at all easy

[If not easy: Why do you say this?
What would have made it easier?]

Approximately how often did you use the FibriCheck app to take a reading of your heart rhythm?

- Twice a day or more
- Once a day
- Occasionally
- Other (please specify)

How easy was it for you to remember to use the FibriCheck app to monitor your heart rhythm?

- Very easy
- Easy
- Not very easy
- Not at all easy

How easy was it for you to understand the results displayed on the FibriCheck app?

- Very easy
- Easy
- Not very easy
- Not at all easy

[If not easy: Why do you say this?]

How satisfied were you overall with using the FibriCheck app to monitor your own heart rhythm ?

- Very satisfied
- Satisfied
- Dissatisfied
- Very dissatisfied

Why do you say this?

Is there anything else you'd like to say about the FibriCheck app?

Is there anything at all that you would like to say about the atrial fibrillation and heart rhythm checks that would help us in its evaluation?

Survey of patients going through the complete pathway

Did you know anything about atrial fibrillation before you were contacted about the checks and the FibriCheck app?

- I already knew a lot about atrial fibrillation
- I already knew something about atrial fibrillation
- I'd heard of atrial fibrillation but didn't know much about it
- I didn't know anything about atrial fibrillation

After reading the information sent to you about atrial fibrillation and the at home heart rhythm checks, did you have a better understanding of atrial fibrillation?

- Yes, I had a much better understanding of atrial fibrillation
- Yes, I had a slightly better understanding of atrial fibrillation
- No, I didn't understand any more about atrial fibrillation
- Other (please specify)

Did you look at the information about atrial fibrillation and the at home heart rhythm checks on the hospital's website? (https://www.wsh.nhs.uk/Services-A-Z/Cardiology/Atrial-fibrillation.aspx?letter=A)

- Yes
- No
- Not sure

[If Yes: how would you rate the information provided about atrial fibrillation on the hospital's website?

- Very good
- Good
- Poor
- Very poor

Is there anything that could be improved about the website or any other information that you would have found useful?]

Did you download and activate the FibriCheck app on your smartphone?

- Yes [continue]
- No [go to end]

How easy was it for you to register with the Fibricheck app and activate the free licence?

- Very easy
- Easy
- Not very easy
- Not at all easy

[If not easy: Why do you say this?
What would have made it easier?]

How easy was it for you to use the Fibricheck app to monitor your heart rhythm?

- Very easy
- Easy
- Not very easy
- Not at all easy

[If not easy: Why do you say this?
What would have made it easier?]

Approximately how often did you use the Fibricheck app to take a reading of your heart rhythm?

- Twice a day or more
- Once a day
- Occasionally
- Other (please specify)

How easy was it for you to remember to use the Fibricheck app to monitor your heart rhythm?

- Very easy
- Easy
- Not very easy
- Not at all easy

How easy was it for you to understand the results displayed on the app?

- Very easy
- Easy
- Not very easy
- Not at all easy

[If not easy: Why do you say this?]

How satisfied were you overall with using the FibriCheck app to monitor your own heart rhythm?

- Very satisfied
- Satisfied
- Dissatisfied
- Very dissatisfied

Why do you say this?

Is there anything else you'd like to say about the FibriCheck app?

Zio XT biosensor patch

How useful was the virtual conversation with a nurse before you were sent the Zio XT biosensor patch?

- Very useful
- Useful
- Not very useful
- Not at all useful

[If not useful: Why do you say this?]

How easy was it for you to apply the Zio XT biosensor patch?

- Very easy
- Easy
- Not very easy
- Not at all easy

[If not easy: Why do you say this?]

How easy was it for you to send the Zio XT biosensor patch back?

- Very easy
- Easy
- Not very easy
- Not at all easy

[If not easy: Why do you say this?]

After sending back the Zio XT biosensor patch, how long did it take for you to hear about the results?

- Less time than you expected
- About the length of time that you expected
- Longer than you expected

How satisfied were you overall with using the Zio XT biosensor patch?

- Very satisfied
- Satisfied
- Dissatisfied
- Very dissatisfied

Why do you say this?

Is there anything else you'd like to say about the Zio XT biosensor patch?

Were you invited to attend a virtual consultation with a cardiology consultant after using the Zio XT biosensor patch?

- Yes [continue]
- No [skip next two questions]

How did you feel about having the virtual consultation with the cardiology consultant?

- I was happy to have a virtual consultation
- I would have preferred an in person consultation
- I didn't really have any preference

Why do you say this?

Is there anything at all that you would like to say about the atrial fibrillation and heart rhythm checks scheme that would help us in its evaluation?

Survey of non-responders to text invite

Did you know anything about atrial fibrillation before you were contacted about this campaign and the FibriCheck app?

- I already knew a lot about atrial fibrillation
- I already knew something about atrial fibrillation
- I'd heard of atrial fibrillation but didn't know much about it
- I didn't know anything about atrial fibrillation

After reading the information sent to you about atrial fibrillation and the at home heart rhythm checks campaign, did you have a better understanding of atrial fibrillation?

- Yes, I had a much better understanding of atrial fibrillation
- Yes, I had a slightly better understanding of atrial fibrillation
- No, I didn't understand any more about atrial fibrillation
- I already knew a lot about atrial fibrillation
- Other (please specify)

Did you look at the information about atrial fibrillation and the at home heart rhythm checks on the hospital's website? (https://www.wsh.nhs.uk/Services-A-Z/Cardiology/Atrial-fibrillation.aspx?letter=A)

- Yes
- No
- Not sure

[If Yes: how would you rate the information provided about atrial fibrillation on the hospital's website?

- Very good
- Good
- Poor
- Very poor

Is there anything that could be improved about the website or any other information that you would have found useful?}

Could we ask why you decided not to download and activate the FibriCheck app on your smartphone? *(Please tick all that apply)*

- I don't have a smartphone
- I didn't understand the information
- I wasn't eligible
- The idea didn't work for me
- I didn't want to do it
- Other (please specify)

What other information might have been useful to you in deciding whether or not to download the FibriCheck app?

Do you have any other comments about the atrial fibrillation and heart rhythm checks scheme?