**Mobile Health technology for atrial fibrillation screening using photoplethysmography-based smart devices: The HUAWEI Heart study**

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MAFA II Investigators: See Online Appendix. Screenshots of App consent and data privacy; and Verification reports of the algorithm and smart devices are shown in Supplementary Online Figure 7, 8, 10, 11.

Abstract

**Background**: Low detection and nonadherence are major problems in current management approaches for patients with suspected atrial fibrillation (AF). Mobile health (mHealth) devices may enable earlier AF detection, and improved AF management.

**Objectives**: To investigate the effectiveness of AF screening in a large population-based cohort using smart device based photoplethysmography (PPG) technology, combined with a clinical care AF management pathway using a mHealth approach.

**Methods**: AF screening was performed with smart devices using PPG technology (Huawei Technologies Co., Ltd., Shenzhen, China) which were made available for the population aged over 18 years across China. Monitoring for at least 14-days with a wristband (HONOR BAND 4) or wristwatch (HUAWEI WATCH GT, HONOR WATCH), was allowed. The patients with ‘possible AF’ episodes using the PPG algorithm were further confirmed by health providers among the MAFA (mobile AF App) Telecare center and network hospitals, with clinical evaluation, electrocardiogram (ECG), or 24-h Holter.

**Results**: There were 246,541 individuals who downloaded the PPG screening App, and 187,912 individuals used smart devices to monitor their pulse rhythm between October 26, 2018 and May 20, 2019. Among those with PPG monitoring (mean age 35 years, 86.7% male), 424 (mean age 54 years, 87.0% male) received a ‘suspected AF’ notification (424/187,912, 0.23%). Of those effectively followed up, 227 individuals (227/262, 87.0%) were confirmed as having AF, with the positive predictive value (PPV) of PPG signals being 91.6% (95% confidential interval (CI) 91.5%-91.8%). Both ‘suspected AF’ and ‘identified AF’ markedly increased with age (p for trend <0.001), and individuals in Northeast China had the highest proportion of detected AF of 0.28% (95%CI 0.20-0.39). Of the individuals with identified AF, 216 (216/227, 95.1%) subsequently entered a programme of integrated AF management using a mobile AF application (mAFA); approximately 80% of ‘high risk’ patients were successfully anticoagulated.

**Conclusions**: Based on the present study, continuous home-monitoring with smart device based PPG technology could be a feasible approach for AF screening. This would help efforts at screening and detection of AF, as well as early interventions to reduce stroke and other AF-related complications.

**Condensed Abstract:** The study aimed to determine the feasibility of AF screening in a large population-based cohort using smart device based photoplethysmography (PPG) technology, combined with a clinical care AF management pathway. There were 187,912 individuals used smart devices to monitor their pulse rhythm between October 26, 2018 and May 20, 2019. 87.0% were confirmed as having AF, with the PPV of PPG signals being 91.6%. Following entry into a programme of integrated AF management using a mobile AF application, approximately 80% of high risk patients were successfully anticoagulated. Based on the present study, continuous home-monitoring with smart device based PPG technology could be a feasible approach for AF screening. This would help efforts at screening and detection of AF, as well as early interventions to reduce stroke and other AF-related complications.

**Keywords**: atrial fibrillation, screening, photoplethysmography, integrated care

**Abbreviations**:

AF = atrial fibrillation

ECG = electrocardiogram

PPG = photoplethysmography

USPSTF = US Preventive Services Task Force

mAF App = mobile atrial fibrillation application

SD = standard deviation

IQR = interquartile range

CI = confidential interval

PPV = positive predictive value

CHA2DS2-VASc = congestive heart failure, hypertension, age ≥75, diabetes, stroke, vascular disease, age 65–74, and sex category (female)

HAS-BLED = hypertension, abnormal renal/liver function, stroke, bleeding history or predisposition, labile international normalised ratio, elderly, drugs/alcohol concomitantly

SAMe-T2T2R = sex female, age, medical history, treatment, tobacco use, race

**Introduction**

Low detection and nonadherence are major problems in current management approaches for patients with suspected atrial fibrillation (AF). AF screening has been advocated with the recognition that this could ultimately reduce AF-related stroke and death, with the initiation of treatments such as oral anticoagulation, and other risk-factor modifications to reduce AF-related complications and arrhythmia progression [1]. Indeed, active screening strategies could improve detection of AF in comparison with routine care. Nonetheless, a systematic screening strategy for AF did not show an obvious advantage to opportunistic screening, using pulse palpation and a 12-lead electrocardiogram (ECG) [2].

Recent advances in mobile and wearable devices provide a possible solution [3]. New technology has been developed to improve the early detection of AF and among these, photoplethysmography (PPG) and single lead ECG recordings are promising methods available to the public for detecting AF [4]. In the STROKESTOP study, a handheld ECG recorder for intermittent ECG recordings over 2 weeks improved AF diagnosis in high-risk population aged 75-76 years old [5]. Another AF screening approach with twice-weekly single-lead ECG recorders among those aged over 65 years identified more incident AF than routine care, but adverse clinical events (including stroke, thromboembolism, death, etc), were not significantly different over a 52-week follow-up period [6]. Hence, it has been questioned how AF screening could have a more beneficial effect on subsequent AF management, and the US Preventive Services Task Force (USPSTF) recently concluded that the current evidence was insufficient to assess the balance of benefits and harms of screening for atrial fibrillation with ECG [7]. Similarly, current UK National Screening Committee policy recommends that population screening for AF should not be offered by the National Health Service [8]. Thus, more evidence on strategies for improving AF screening, detection and subsequent management to reduce AF-related adverse outcomes is needed.

Approaches using random brief ECG screening could possibly miss those individuals with a low burden of (paroxysmal) AF, and long-term continuous screening may overcome the problem. An ECG skin adhesive patch, which could provide 14-day monitoring, resulted in a higher proportion of AF diagnosis compared with delayed monitoring; however, nearly one third of subjects refused to use the ECG patch, and some individuals reported skin irritation, resulting in early discontinuation structured management [9]. A smartwatch strap with single ECG sensor may be a more comfortable method, with 93% sensitivity and 84% specificity of AF diagnosis compared to a 12 lead ECG, but only 66% of monitored signals could be interpretable with the App algorithm alone[10]. Thus, the stability of the signal quality and motion artifacts are additional considerations when considering an ECG-based approach to AF screening.

In contrast, increasing evidence supports PPG-monitoring for AF screening [11,12,13]. Mass screening for AF has been carried out using smartphone cameras with reliable PPG signals [14]. In our previous pilot study, both smartphones and smart bands with PPG demonstrated good performance in detecting AF [15]. Hence, it may be more practical to screen for AF in a large population using a PPG-based smart device, especially if integrated with a structured management programme for AF, again based on smart technology. In a pilot study of such a structured management programme, we showed that a mHealth technology-supported AF application (mAF App) could be developed and validated, integrating patient clinical decision support tools, guideline-based treatment, educational materials and patient involvement strategies with self-care protocols and structured follow-up [16].

In the Huawei Heart Study, our aim was to screen for AF and report the incidence of AF identified, as well as the proportion of AF patients being anticoagulated. We hypothesised that use of a mobile health PPG technology approach would facilitate AF screening, and the associated App-based integrated AF care approach would result in early AF detection and increased use of oral anticoagulation. The latter could have the potential in reducing AF-related complications such as stroke and mortality [17].

**Methods**

The Mobile health technology for improved screening, patient involvement and optimizing integrated care in Atrial Fibrillation (MAFA II) study programme was developed to verify a screening and integrated care approach to improving AF management. The ‘Pre-MAFA’ study was the first stage of the MAFA II programme, using HUAWEI smart technology (herein referred to as the ‘Huawei Heart Study’) to test the feasibility of continuous home-monitoring with PPG technology in a large population [18] (Online Figure 1). Identified AF patients were then transferred into a structured programme of holistic and integrated care using a smartphone App (mAF App) [18]. The present report only focuses on the ‘Huawei Heart Study’, which is the AF screening component (‘Pre-MAFA’) of this programme.

AF screening with smart devices using PPG technology (Huawei Technologies Co., Ltd., Shenzhen, China) were made available for the population aged over 18 years across China. Inclusion criteria included use of the Huawei phone (Android 5.0 or higher), and one of following smart devices: Huawei Watch GT (Version 1.0.3.52 or higher), Honor Watch (Version 1.0.3.52 or higher), and Honor Band 4 (Version 1.0.0.86 or higher). The participants needed to have compatible HUAWEI smart device(s) and phone. Exclusion criteria included age <18 years, and inability to use smart phone or devices. At least 14-day monitoring with smart devices based on PPG (with the PPG algorithm developed by Huawei) was proposed. The study was approved by the Central Medical Ethic Committee of Chinese PLA General Hospital (Approval number: S2017-105-02) and registered at www.chictr.org.cn (ChiCTR-OOC-17014138). Subjects could freely download the App in the HUAWEI Appstore. All subjects who were interested in the study were informed of the study design and gave their informed consent before entering the study. Adults downloading the AF screening App across China mainland were enrolled into present Pre-MAFA study analysis between October 26, 2018 to May 20, 2019.

*AF detection*

An AF screening App was developed based on the Android Operating System (Google Inc., Mountain View, Calif). The individuals could initiate rhythm monitoring with AF screening App using smart devices. The users could also start directly AF detection with MAFA (**Figure 1**). The irregular pulse wave would be screened with active or periodic measuring using the PPG algorithm. Individuals could initiate active measurements at rest, and 45-second PPG signals would be collected. Periodic measurements would be automatically be taken every 10 minutes, and 60-second PPG signals would continuously be collected. The discrimination rule of the PPG algorithm and notification of ‘suspected AF’ is shown in **Figure 2.** A notification of ‘suspected AF’ would be delivered, once the proportion of ‘possible AF’ episodes was 100%, when ten measurements were initiated. In the case of PPG measurements >10, the threshold T was set to ensure that the positive predictive value of making a decision was over 0.85, and the sensitivity would be as high as possible. The T could be adjusted to a more suitable value with enough study data were collected. The notification of ‘suspected AF’ would also be delivered once the proportion of ‘possible AF’ episodes over threshold T in the setting of PPG measurements was >10 (**Figure 2)**.

AF *diagnosis* and management

The individuals with ‘suspected AF’ episodes using the PPG algorithm were further confirmed by the health providers using the MAFA Telecare center and network hospitals, with clinical evaluation, ECG, or 24-h Holter (Online Figure 2). Individuals with ‘identified AF’ would be managed according to an App-based AF integrated care pathway approach, based on the ABC (‘A’ Avoid stroke, ‘B’ Better symptom management, and ‘C’ Cardiovascular risk and comorbidity management) pathway [19]. The ABC pathway approach has been associated with improved clinical outcomes in various independent cohorts [20,21,22].

*Statistical analysis*

Continuous variables were tested for normality by the Kolmogorov-Smirnov test. Data with a normal distribution were presented as a mean (standard deviation, SD). Data with a non-normal distribution were presented as median (interquartile range, IQR) and were analyzed by using Kruskal-Wallis test. χ2 test was used for categorical variables. Data visualization analysis was utilized for the enrollment across China with ECharts, version 4.2.1 (Apache Software Foundation).

The “irregular pulse rhythm” by PPG algorithm was observed, and the predictive ability of AF with PPG algorithm was analyzed in comparison with the confirmed diagnosis of AF using clinical evaluation, ECG, or 24-h Holter by the health providers from the MAFA Telecare center and network hospitals. The proportion of "identified" AF from the general population screening that were enrolled into the subsequent main MAFA integrated care trial was calculated to explore the feasibility of the approach AF screening combined with integrated care.

The monitoring method for first “suspected” AF was calculated, and “suspected” AF episodes in relation to measurement method, the automatic periodical measurements and active measurements, were analyzed using the Kruskal-Wallis test for the comparations among different measurement approaches. Moreover, the influence of the continuous monitoring time on first detected "suspected" and “identified" AF episodes were investigated, to explore the optimal screening "window". Incident AF was analysed in relation to age strata, sex, and region. Finally, AF management among individuals with "identified" AF enrolled into an App-based AF integrated care structured programme with the mAFA trial, were investigated, including their stroke risk, bleeding risk, and the likelihood for good anticoagulation control. Anticoagulant use classified by risk assessment is reported, while the changes on oral anticoagulant use among different risk strata were compared.

A two-sided P-value < 0.05 was considered as statistically significant. The 95% confidential intervals (CIs) were calculated with Wilson score method without continuity correction [18]. Statistical analysis was performed using IBM SPSS Statistics, version 25.0 (SPSS Inc.).

**Results**

There were 246541 individuals who downloaded the PPG screening App, and 187912 individuals used smart devices to monitor their pulse rhythm between October 26, 2018 and May 20, 2019. Enrollment and baseline characteristics are summarized in OnlineFigure 3 **and Table 1.**

*Monitoring method and identification*

There were 265,139 ‘suspected AF’ episodes for 424 subjects (mean age 54 years, 87.0% male) among 187,912 subjects screened (mean age 35 years, 86.7% male). Of the ‘suspected AF’ subjects, 262 (262/424, 61.8%) were effectively followed up with full medical history, physical examination, ECG, or 24-hour Holter (**Figure 3**). Of those with full assessment, 227 (227/262, 87.0%) subjects were confirmed as having AF. Cardiac rhythms of ‘suspected AF’ episodes are summarized in Online Figure 4.

There were 186,956 ‘identified AF’ episodes for the 227 subjects and 203,985 episodes for the 262 ‘suspected AF’ subjects. The positive predictive value (PPV) of PPG signals was 91.6% (95%CI 91.5%-91.8%). Individuals with ‘suspected AF’ episodes were mostly monitored using automatic periodical measurements (periodical vs. active measurements, 37.0% vs. 7.6%, p<0.001) (Online Figure 5, Online Table 1). 70.8% of AF episodes were found within 14 days, but nearly one third of AF episodes were recorded after two weeks (**Figure 4**). The distribution of monitoring time in the whole cohort is shown in Online Figure 9. Supplementary material online summarises user reported adverse events (Online Table 2), a comparison performance of the various smart devices utilized in PPG screening (Online Table 3), and the standby time of the various smart devices with or without PPG screening (Online Table 4). They show generally high specificity (approx. 99%), sensitivity (100%) and accuracy (>99%), irrespective of smart device used.

*AF episodes in the general population*

Incident ‘suspected AF’ and ‘identified’ AF markedly increased with age (p for trend <0.001) (**Figure 5**). The highest proportion of AF episodes was among the elderly, ie. those aged over 65 years, with 2.78% (95% CI 2.28-3.38) being ‘suspected AF’, and 1.70% (1.31-2.19) being ‘identified’ AF (**Figure 5**). There was a higher risk of incident AF in individuals aged over 55 years compared to those aged under 55 years (2.62% vs 0.17%; p<0.001). The prevalence of detected AF was highest in Northeast China compared to other regions in China (p<0.001, Online Figure 6).

*AF management*

216 (216/227, 95.1%) individuals with ‘identified AF’ were entered into an App-based AF integrated care structured programme with MAFA (**Figure 3**); of these, 29 (29/216,13.42%) who initiated MAFA to monitor the rhythm were subsequently found to have a known AF diagnosis. Clinical decision support tools were provided for doctors and patients (Online Table 5). The patient’s personized stroke risk was assessed with the CHA2DS2-VASc score (mean, SD, 1.07, 1.09), while bleeding risk was assessed using the HAS-BLED score (mean, SD, 0.35, 0.52), respectively. Their likelihood for good anticoagulation control was assessed using the SAMe-T2T2R score (mean, SD, 3.71, 0.66). Distribution of subjects according to these scores are shown in Online Table 5.

Overall, 79.6% of patients at high-risk were anticoagulated (Table 3). There was no difference in risk characteristics and anticoagulant use among high-risk individuals comparing individuals with newly detected AF and with known AF (Table 2).

**Discussion**

In the Huawei Heart Study, we show that PPG-based smart devices were feasible as an easy-to-use screening tool in this population-based, large-scale AF screening study, with a good performance for AF detection. Second, the heterogeneity of incident AF, in relation to regions and age, suggests the need for a different prevention approaches based on local population requirements. Thus, the use of mobile and wearable devices could provide a simple, feasible and practical mHealth approach for AF early detection, that can be followed by guideline-guided App-based intervention.

AF management integrated with AF detection might provide more benefits for patients. Previous studies have demonstrated that smart devices (smartphone, E-patch, handing device, wrist band, etc.) can be used for AF detection [5,6,9,10,11,12,13,14,15]; however, an integration with subsequent clinical management of ‘screened AF’ was lacking. In the present Huawei Heart Study (Pre-MAFA), 95.1% of individuals with identified AF, who screened from general population, were entered into an AF integrated care programme with MAFA, providing guideline-guided intervention and leading to a high proportion of patients being successfully anticoagulated.

The clinical decision support within the MAFA programme with CHA2DS2-VASc, HAS-BLED, and SAMe-TT2R2 scores on the MAFA platform provides risk-assessment advice for doctors, and facilitates sharing decision making for the patients. In this study, approximately 80% of ‘high risk’ AF patients in MAFA received oral anticoagulants (OACs), which is a marked improvement over prior reports of suboptimal thromboprophylaxis in prior Chinese cohorts [23,24,25]. Thus, AF screening, combined with a clinical integrated care programme for detected AF, may translate to better treatment and prevention of AF-related major complications, such as stroke and death.

The continuity, comfort and the stability of monitoring signals, that are not influenced by motion, are challenges for a good predictive ability for AF using smart devices. A lower accuracy in ambulatory than sedentary patients has been observed with a Cardiogram app using a wristwatch [26]. Indeed, only 66% of monitoring signals could be interpretable with a single-lead ECG wristwatch by App algorithm alone [10]. In the present study, 91.6% of PPG positive signals by algorithm were confirmed as AF. The improved screening ability of AF with the present PPG-based smart devices possibly stems from frequent, continuous monitoring and the good quality of monitoring signals. With a single battery life (average standby time with HUAWEI smart devices is 6.7 days with PPG screening), periodic measurements could be taken automatically every 10 minutes in this study, which was far more frequent than obtained from the Apple watch in the Apple Heart Study, with measurements only taken every two hours at baseline, which was then increased to every 16 minutes once an irregular tachogram was detected [27]. In addition, the discrimination of the PPG algorithm could possibly contribute to the better detection of AF, as shown in this study.

Our study found that most AF episodes were found within 14 days, but nearly one third of AF episodes were detected on monitoring after two weeks. In the case of paroxysmal AF, the time to the first detection has been inversely related to AF burden [28,29]. Automatic periodic PPG measurements have the advantage of active measurements in the search for AF episodes in this study, suggesting that a continuing monitoring approach was better than single-point intermittent monitoring. Our study also supports the possibility that PPG-based wrist-worn wearables (watches, bands) would be the good choices for AF screening [30,31].

In this study, the prevalence of ‘suspected AF’ of 0.2% in the general population was lower than the 0.5% reported in Apple Heart Study [27]. There are possibly several reasons for this. This was much younger population with 1.8% who were aged over 65 years old in the present study, compared to 6% being aged over 65 years old in Apple Heart Study [27]. There is also a lower incidence and prevalence of AF in the Chinese population compared to the Western population [32,33]. The strict discrimination rule of the PPG algorithm may also contribute to the low prevalence of detected AF.

However, a trend for increasing detected AF with aging was evident in the Chinese population, with a fifteen-fold (2.62/0.17) greater AF risk in those aged >55 years compared to those aged < 55 years; this difference was only eight-fold (4.5/0.53) in the Apple Heart Study. AF screening might be much more beneficial for those at high-risk of AF, e.g. population with age > 55 years. The cost effectiveness of AF screening related to different population risks would need to be ascertained in future studies. In addition, we noted a geographical difference in incident AF in the present study, with the highest prevalence of AF in Northeast China that was consistent with the distribution of clinical risk factors for AF (Supplementary online Table 6). The heterogeneity of risk factors incident AF may suggest the need for different prevention approaches in different settings based on local clinical risk profiles.

*Strengths and limitations*

There were several limitations in this study. We were not doing a trial of the efficiency of AF screening since the current study relates to the "yield" with the current technology and the specificity of the diagnosis, rather than sensitivity. Although we had strict follow-up procedures for ‘suspected AF’, there were 38% of individuals with ‘suspected AF’ who could not be effectively followed up, which would decrease the proportion of identified AF. For the PPV calculation with PPG signals, we did not have real-time 12-lead ECG data synchronized with PPG-based smart devices. Indeed, it would be difficult to make all individuals have a 14-day 12-lead Holter examination with a mass population screening study. However, the diagnosis of AF was confirmed with medical history, physical examination, ECG or 24-Holter by healthcare providers. While we aimed to focus on newly diagnosed or detected AF, 29 subjects were subsequently found to have known AF, as was also seen in the Apple Heart Study, where 15% with known AF entered that study [27]. Also, incident AF detection in present study might be impacted by the availability of smart phones and devices. In the present study, 24% of subjects downloaded the App but were without compatible smart devices. The underlying reason(s) may be multifactorial; however, 187,912 individuals were entered into the study, suggested the PPG-based smart device could still be a feasible screening strategy. Finally, we did not report on hard outcomes (stroke, death, etc) impacted with AF screening approach in the present Pre-MAFA study and would be further reported in the future from the ongoing MAFA II trial [18].

**Conclusion**

Continuous home-monitoring with smart device based PPG technology is a feasible approach for screening and early detection of AF in a large population. This could help efforts at screening and detection of AF, as well as early interventions to reduce stroke and other AF-related complications.

Perspectives

COMPETENCY IN PATIENT CARE AND PROCEDURAL SKILLS: We demonstrate the feasibility of AF screening in a large population-based cohort using smart device based photoplethysmography (PPG) technology, combined with a clinical care AF management pathway (**Central Illustration**). Following entry into a programme of integrated AF management using a mobile AF application, approximately 80% of high risk patients were successfully anticoagulated.

TRANSLATIONAL OUTLOOK: Continuous home-monitoring with smart device based PPG technology could be a feasible approach for AF screening. This would help efforts at screening and detection of AF, as well as early interventions to reduce stroke and other AF-related complications. This integrated approach should be verified in randomized trials.

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**Figure Legends**

**Figure 1: AF screening flow diagram.** \*MAFA: mobile Atrial Fibrillation Application.

**Figure 2: The notification of “suspected” AF by algorithm**. \*N>10, 0<T<1, seen AF detection in the Method in the text.

**Figure 3: AF screening, confirmation, and transference into MAFA**. Inclusion: Adult ≥18 years; Huawei phone (Android 5.0 or higher); Smart devices: Huawei Watch GT (Version 1.0.3.52 or higher), Honor Watch (Version 1.0.3.52 or higher), Honor Band 4 (Version 1.0.0.86 or higher). Exclusion: Adult <18 years; Inability to use smart phone or devices.

**Figure 4: Monitoring time to first AF episode**. The monitoring time to first detected AF episode were classified by 0-7 days, 8-14 days, 15-21 days, 22-30 days, and >31 days.

**Figure 5: Incident “suspected” and “identified” AF among 187,912 population.** The incident "suspected" and "identified" AF were shown in relation to age- and sex-proportions.

**Central Illustration: Mobile health devices could be a feasible approach for AF screening, and into subsequent AF integrated management.** MAFA: mobile Atrial Fibrillation Application.

**Table 1: Baseline characteristics.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | Overall Cohort  (n=187,912) | Notification  (n=424) | Individuals with clinical evaluation  (n=262) | Identified AF  (n=227) |
| Suspected AF episodes, n | | 265,139 | 265,139 | 203,985 | 186,956 |
| Female, n (%) | | 24938 (13.3) | 55(13.0) | 43(16.4) | 42(18.5) |
| Age, mean (SD) | | 34.7(11.5) | 54.1(14.3) | 54.9(14.0) | 56.1(13.7) |
|  | ≥65, n (%) | 3419 (1.8) | 95(22.4) | 62(23.7) | 58(25.5) |
|  | 55-64, n (%) | 7491 (4.0) | 112(26.4) | 71(27.1) | 69(30.4) |
|  | 40-54, n (%) | 44432 (23.6) | 136(32.1) | 82(31.3) | 64(28.2) |
|  | 20-39, n (%) | 132570 (70.5) | 81 (19.1) | 47(17.9) | 36(15.9) |
| Location | |  |  |  |  |
|  | East China, n (%) | 57,177 (30.4) | 116 (27.4) | 67 (25.6) | 58 (25.6) |
|  | North China, n (%) | 32,488 (17.3) | 98 (23.1) | 71 (27.1) | 63 (27.8) |
|  | Central China, n (%) | 26,033 (13.9) | 42 (9.9) | 25 (9.5) | 19 (8.4) |
|  | South China, n (%) | 21,333 (11.4) | 36 (8.5) | 23 (8.8) | 20 (8.8) |
|  | Southwest China, n (%) | 17,156 (9.1) | 30 (7.1) | 15 (5.7) | 13 (5.7) |
|  | Northwest China, n (%) | 12,762 (6.8) | 30 (7.1) | 15 (5.7) | 14 (6.2) |
|  | Northeast China, n (%) | 12,805 (6.8) | 62 (14.6) | 42 (16.0) | 36 (15.9) |
|  | Others, n (%) | 8,158 (4.3) | 10 (2.4) | 4 (1.5) | 4 (1.8) |

**Table 2: Risk assessments and anticoagulant use of the 216 patients entered into the MAFA programme.**

|  |  |  |  |
| --- | --- | --- | --- |
| (n,%) | Individuals with newly detected AF  (n=187) | Individuals with known AF  (n=29) | p |
| CHA2DS2-VASc score |  |  |  |
| (mean, SD) | 1.04(1.05) | 1.24 (1.35) | 0.365 |
| (median, interquartile range) | 1(0-2) | 1(0-2) |  |
| HAS-BLED score |  |  |  |
| (mean, SD) | 0.33(0.52) | 0.48(0.57) | 0.141 |
| (median, interquartile range) | 0(0-1) | 0(0-1) |  |
| SAMe-T2T2R score |  |  |  |
| (mean, SD) | 3.72 (0.63) | 3.66 (0.85) | 0.644 |
| (medican, interquartile range) | 4(3-4) | 4(3-4) |  |
| \*Individuals at high risk (n,%) | 46 (24.60) | 8 (27.59) | 0.730 |
| Anticoagulant use amongst patients at high risk | 35(76.09) | 8 (100%) | 0.266 |

\* Individuals at high risk: CHA2DS2-VASc ≥3 in females, ≥2 in males.

See Figure 3 for patient flow.

**Table 3: Oral anticoagulant use in AF patients.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Low risk | Intermediate risk | High risk |
| N ( %) | 91 (42.1) | 71(32.9） | 54 (25.0) |
| Anticoagulant use at baseline, n% | 5 (5.49) | 9 (12.68) | 43 (79.63) |
| Anticoagulant use at 3 months, n% | 3 (3.30) | 29 (40.85) | 42 (77.78) |
| p | 0.372 | <0.001 | 0.673 |

\* Low risk: CHA2DS2-VASc of 0 in males, or 1 in females; Intermediate risk: CHA2DS2-VASc of 2 in female, 1 in male; High risk: CHA2DS2-VASc ≥3 in females, ≥2 in males. McNemar's test was used for testing the difference.

The reasons for patients with or without oral anticoagulants (OACs) on baseline:

* Low risk patients with OACs at baseline: 2 patients undergoing AF ablation, with OAC used after discharge, 2 patients with current onset acute AF episodes, and 1 patient with rheumatic valvular heart disease.
* High risk patients without OACs at baseline: six patients who were unwilling to accept anticoagulants, four patients with antiplatelets (aspirin or clopidogrel), and one patient anticoagulated with traditional Chinese medicine.