Postprint of a Study on the Effectiveness of Different Screening Methods for Atrial Fibrillation in Community-Dwelling Elderly Populations

Authors: Shi Yushuang, Wang Huihua, Li Yan, Lu Ping, Song Wei, Pan Guijun, Pan Guijun

Date: 2023-12-19T00:00:00+00:00

Abstract

Background Elderly individuals are a high-risk population for atrial fibrillation (AF). Improving screening efficiency for AF among community-dwelling elderly populations helps reduce the risk of AF-related stroke.

Objective To compare the screening efficiency of different AF screening methods in elderly populations.

Methods From July 2022 to January 2023, 1,300 elderly individuals were selected from three residential committees (Xiangshan, Huangshan, and Luoshan) in Jinyang Community, Pudong New Area, Shanghai. Participants were sequentially screened for AF using radial artery pulse palpation, an electronic blood pressure monitor with AF detection function, and a single-lead ECG recorder. A positive result from any of the three methods was considered AF-positive, with final diagnosis confirmed by an ECG room physician through ECG examination and interpretation. ROC curves were plotted for different screening methods, AUC was calculated, and their screening value was evaluated. The ^{2} test for trend was used to analyze the correlation between CHA2DS2-VASc score and AF.

Results Among the 1,300 participants, 93 were diagnosed with AF, including 57 asymptomatic individuals. Pulse palpation was positive in 375 participants, the electronic blood pressure monitor with AF detection function was positive in 331 participants, and the single-lead ECG recorder was positive in 128 participants. The AUC values for diagnosing AF in community-dwelling elderly were 0.750 (95%CI=0.697~0.803, P<0.01) for pulse palpation, 0.832 (95%CI=0.790~0.874, P<0.01) for the electronic blood pressure monitor with AF detection function, and 0.939 (95%CI=0.916~0.973, P<0.01) for the single-lead ECG recorder. As

the CHA2DS2-VASc score increased, the incidence of AF in elderly individuals progressively increased (^{2} trend=197.46, P<0.01).

Conclusion Using portable single-lead ECG devices for AF screening is convenient, efficient, and accurate, and can be promoted for AF screening among community-dwelling elderly populations.

Full Text

Analysis of the Effectiveness of Different Atrial Fibrillation Screening Methods in a Community-Based Elderly Population

SHI Yushuang, WANG Huihua, LI Yan, LU Ping, SONG Wei, PAN Guijun*

Department of General Practice, Jinyang Community Health Service Center of Pudong New Area, Shanghai 200136, China

Corresponding author: PAN Guijun, Associate Chief Physician; E-mail: panguijun@163.com

---

Abstract

Background: Older adults are at high risk for atrial fibrillation (AF). Improving the efficiency of AF screening among community-dwelling elderly populations can help reduce the risk of AF-related stroke.

Objective: To compare the screening efficiency of different AF screening methods in elderly populations.

Methods: A total of 1,300 older adults were recruited from three neighborhood committees (Xiangshan, Huangshan, and Luoshan) in Jinyang Community, Pudong New Area, Shanghai, between July 2022 and January 2023. Participants underwent three sequential AF screening methods: palpation of the radial artery pulse, an electronic sphygmomanometer with AF detection function, and a single-lead ECG recorder. A positive result from any of the three methods was considered AF-positive, with final confirmation via 12-lead ECG interpretation by a qualified ECG technician. Receiver operating characteristic (ROC) curves were plotted for each screening method, and the area under the curve (AUC) was calculated to evaluate screening performance. The association between CHA2DS2-VASc score (a stroke risk stratification tool) and AF prevalence was analyzed using chi-square test for trend.

Results: Among 1,300 participants, AF was detected in 93 individuals, including 57 asymptomatic cases. The three methods yielded 375 positive results by pulse palpation, 331 by the AF-enabled blood pressure monitor, and 128

by the single-lead ECG recorder. The AUCs for diagnosing AF in community elderly were 0.750 (95%CI=0.697-0.803, P<0.01) for pulse palpation, 0.832 (95%CI=0.790-0.874, P<0.01) for the electronic sphygmomanometer, and 0.939 (95%CI=0.916-0.973, P<0.01) for the single-lead ECG recorder. AF prevalence increased significantly with higher CHA2DS2-VASc scores (^{2} trend=197.46, P<0.01).

Conclusion: Portable single-lead ECG recorders offer a convenient, efficient, and accurate method for AF screening and can be recommended for widespread use in community-based elderly populations.

Keywords: Atrial fibrillation; Aged; Community; Palpation; Sphygmomanometers; Electrocardiogram; CHA2DS2-VASc score; Screening

Introduction

Atrial fibrillation (AF) is a common arrhythmia among older adults and represents a major risk factor for stroke, cardiovascular disease, and all-cause mortality. AF increases stroke risk fivefold, with approximately one-quarter of cases presenting as asymptomatic and 25% of patients receiving their diagnosis only after experiencing a stroke. Although oral anticoagulation therapy substantially reduces AF-related stroke risk, underutilization of this effective treatment and delayed diagnosis remain primary obstacles to stroke prevention. Consequently, early AF screening in elderly populations is essential.

Current AF screening research has focused primarily on implantable electronic devices and wearable technologies. However, elderly community populations often have lower education levels, slower reaction times, and reduced acceptance of new technologies, making the high cost and complex operation of these devices difficult to implement on a large scale. Few studies have examined how to optimize AF screening efficiency specifically for community-dwelling elderly populations. This study compares the effectiveness of three simple and practical AF screening methods to identify optimal approaches and workflows for elderly community screening.

Methods

Study Population The study was conducted from July 2022 to January 2023. Participants were recruited from three neighborhood committees (Xiangshan, Huangshan, and Luoshan) in Jinyang Community, Pudong New Area, Shanghai. Recruitment announcements were distributed through community committees, and interested elderly residents registered voluntarily. Researchers then screened potential participants based on the following criteria: **Inclusion:** age $ $65 years and voluntary participation. **Exclusion:** severe dementia, psychiatric disorders, inability to cooperate with examinations, or prior AF diagnosis confirmed by ECG or 24-hour Holter monitoring. All participants provided in-

formed consent. The study protocol complied with medical ethics standards and was approved by the Medical Ethics Committee of Jinyang Community Health Service Center (JYKJ-2023-03). A total of 1,300 participants were ultimately enrolled, including 559 males and 741 females.

Screening Instruments The study utilized two primary devices: (1) the Microlife BPMS-4V intelligent blood pressure monitor (produced by Huayue Electronics Co., Ltd.), an electronic sphygmomanometer with integrated AF detection capability; and (2) the "Xin' anbao" portable single-lead ECG recorder (Model ER2, produced by Shenzhen Yuandong Innovation Technology Co., Ltd.). The ECG recorder features two sensors that capture bipolar limb lead I ECG signals via dry electrodes. Participants lightly touch both sensors while the device automatically records a 30-second bipolar limb lead I ECG tracing [Figure 30: see original paper], with data saved and exported through the accompanying "Lepu Health" mobile application. When AF diagnosis was uncertain, ECG tracings could be transmitted wirelessly to a cardiology specialist for remote interpretation.

Screening Procedures Information Collection: Research team members established health records for all participants, collecting baseline data including demographic information, lifestyle factors, medical history (diabetes, hypertension, vascular disease, ischemic cerebrovascular disease), and CHA2DS2-VASc scores to assess stroke risk.

Screening Protocol: Each participant underwent all three screening methods sequentially. First, trained volunteers performed a 15-second radial artery pulse palpation. Next, participants had their blood pressure measured three times automatically using the AF-enabled electronic sphygmomanometer. Finally, researchers conducted a 30-second single-lead ECG recording. All participants then received a standard 12-lead ECG performed and interpreted by a qualified ECG technician. For participants identified as high stroke risk, researchers instructed them and their families on self-pulse palpation techniques at home and provided contact cards. If irregular pulses were detected, participants were advised to contact the research team promptly for 12-lead ECG or 24-hour Holter monitoring. High-risk participants were also invited to repeat the screening process every 2-4 weeks at outpatient clinics, community health service stations, or neighborhood activity centers until either AF was detected or the study period ended.

Diagnostic Definitions Medical History Criteria: - *Diabetes:* Currently taking hypoglycemic medication or documented diagnosis at a secondary/tertiary hospital. - *Hypertension:* Currently taking antihypertensive medication or documented diagnosis at a secondary/tertiary hospital. - *Vascular disease:* History of myocardial infarction, percutaneous coronary intervention, coronary artery bypass grafting, or coronary/ peripheral artery

disease confirmed by imaging. - *Ischemic cerebrovascular disease:* Imaging-confirmed ischemic stroke or documented history of ischemic stroke/TIA at a secondary/tertiary hospital. - *Congestive heart failure:* Moderate-to-severe left ventricular systolic dysfunction on cardiac imaging or documented clinical diagnosis at a secondary/tertiary hospital.

CHA2DS2-VASc Scoring: The scoring system assigns points for congestive heart failure, hypertension, age $ $75 years (2 points), diabetes, prior stroke/TIA (2 points), vascular disease, age 65-74 years, and female sex (1 point each), with a maximum of 9 points. High stroke risk was defined as $ $2 points for men and $ $3 points for women.

Positivity Criteria for Screening Methods: - *Pulse palpation:* Irregular radial pulse during 15-second examination. - *AF-enabled sphygmomanometer:* AFIB icon displayed on the device during blood pressure measurement. - *Single-lead ECG recorder:* Absence of P waves with irregular rhythm on the 30-second tracing.

Asymptomatic AF Definition: Absence of subjective symptoms such as palpitations, shortness of breath, chest pain, fatigue, or reduced exercise tolerance, and no medical consultation for such symptoms.

Statistical Analysis SPSS 26.0 software was used for all analyses. ROC curves were constructed to evaluate the diagnostic performance of pulse palpation, the AF-enabled electronic sphygmomanometer, and the single-lead ECG recorder, with AUC values calculated. The chi-square test for trend assessed the association between CHA2DS2-VASc scores and AF prevalence. Statistical significance was set at $P<0.05$.

Results

Detection Performance of Three Screening Methods Among 1,300 participants, AF was detected in 93 individuals (7.2%), including 57 asymptomatic cases (61.3% of all AF cases). The three screening methods yielded the following results: pulse palpation was positive in 375 participants (70 true positives, 305 false positives, 902 true negatives, 23 false negatives); the AF-enabled blood pressure monitor was positive in 331 participants (81 true positives, 250 false positives, 957 true negatives, 12 false negatives); and the single-lead ECG recorder was positive in 128 participants (85 true positives, 43 false positives, 1,164 true negatives, 8 false negatives).

The AUCs for diagnosing AF in community elderly were 0.750 (95%CI=0.697-0.803, $P<0.01$) for pulse palpation, 0.832 (95%CI=0.790-0.874, $P<0.01$) for the electronic sphygmomanometer, and 0.939 (95%CI=0.916-0.973, $P<0.01$) for the single-lead ECG recorder , [Figure 1: see original paper].

Correlation Analysis AF prevalence increased progressively with higher CHA2DS2-VASc scores: 1.15% (2/172) for score 1, 2.33% (10/430) for score

2, 3.93% (17/433) for score 3, 16.76% (31/185) for score 4, 38.46% (20/52) for score 5, and 46.43% (13/28) for score 6 (^{2} trend=142.67, P<0.01).

Discussion

All three screening methods demonstrated high sensitivity, but specificity varied significantly, with pulse palpation showing the lowest specificity (74.7%), followed by the AF-enabled sphygmomanometer, while the portable single-lead ECG recorder achieved the highest specificity. The specificity of pulse palpation in our study aligns with recommendations from the 2020 European Association for Cardio-Thoracic Surgery (EACTS) guidelines. Although pulse palpation is the most convenient and economical method, its lower specificity may result from variability in operators' technical proficiency. The AF-enabled sphygmomanometer requires three blood pressure measurements, making it more time-consuming, and may have limitations in distinguishing atrial flutter from premature ventricular or atrial contractions.

The single-lead ECG recorder demonstrated both high sensitivity and specificity. Orchard et al. reported that among individuals aged $ $75 years, single-lead ECG devices detected AF at 4.8 times the efficiency of single 12-lead ECG screening. The method is simple, rapid, and allows direct visualization of tracings. In practice, we found that its novel design and operation attracted elderly participants' attention and increased engagement, while saving time for both screeners and participants.

Although 12-lead ECG remains the clinical gold standard for AF diagnosis, its cost-effectiveness for large-scale population screening is unclear, and its single-timepoint nature may miss asymptomatic or paroxysmal AF. Long-term Holter monitoring or 1-2 week continuous ECG patch monitoring can improve detection of paroxysmal and asymptomatic AF but are prohibitively expensive for large-scale community application. Opportunistic screening, while less sensitive and specific than ECG, offers convenience and simplicity for implementation in diverse settings such as outpatient clinics, communities, and homes. After brief training, community pharmacies, senior activity centers, health stations, and families could deploy AF-enabled sphygmomanometers or single-lead ECG recorders for repeated screening, with positive results prompting timely medical referral. This low-cost, repeatable approach facilitates detection of asymptomatic and paroxysmal AF.

Given the substantial workload of AF screening, identifying predictive factors could help target high-risk populations, improving efficiency and reducing costs. Our trend analysis revealed that AF prevalence increased significantly with higher CHA2DS2-VASc scores (P<0.01). Several small-scale studies have identified CHA2DS2-VASc score as an AF risk predictor in specific populations. Lee et al. found that age and CHA2DS2-VASc score were significant predictors of postoperative AF following lobectomy, with age $ $75 years and score $ $5 substantially increasing risk. A cross-sectional study of 416 geriatric ward patients

demonstrated CHA2DS2-VASc score as a significant AF predictor (AUC=0.75, 95%CI=0.7-0.8, P<0.001), with 4 points identified as the optimal cutoff. Yang et al. reported similar findings in a community-based study of 328 elderly individuals, where AF prevalence exceeded 5% among those with scores $ $3 and reached 40% for scores >6. Our findings are consistent with these studies, likely because CHA2DS2-VASc components such as age, hypertension, heart failure, and diabetes are themselves established AF risk factors. However, existing evidence derives from small-scale studies in specific populations (e.g., postoperative patients, geriatric ward residents), and multicenter, large-scale evidence is lacking. Therefore, CHA2DS2-VASc score cannot yet be widely recommended as a universal AF prediction tool for all elderly populations, though it offers a promising approach for targeting screening efforts to improve cost-effectiveness.

Study Limitations First, some data were self-reported by participants, potentially introducing information bias. Second, our study population comprised elderly residents from a single community in Shanghai' s Pudong district, which may limit generalizability due to regional differences. Third, for cost considerations, we used standard 12-lead ECG rather than Holter or other long-term cardiac monitoring to confirm AF diagnosis, which may have resulted in missed cases.

Conclusion

Portable single-lead ECG recorders provide a convenient, efficient, and highly specific method for AF screening and can be recommended for widespread implementation in community-based elderly populations. The CHA2DS2-VASc score may serve as a valuable predictor of AF risk in elderly individuals, potentially offering a cost-effective strategy for targeted screening.

References

[1] YANG Zhen, LI Jing, JIA Shaobin. Screening for atrial fibrillation in patients with cryptogenic stroke[J]. Advances in Cardiovascular Diseases, 2016, 37(1): 69-74. DOI:10.16806/j.cnki.issn.1004-3934.2016.01.018.

[2] SIU C W, LIP G Y, LAM K F, et al. Risk of stroke and intracranial hemorrhage in 9727 Chinese with atrial fibrillation in Hong Kong[J]. Heart Rhythm, 2014, 11(8): 1401-1408. DOI:10.1016/j.hrthm.2014.04.021.

[3] HERMANS A N L, GAWALKO M, DOHMEN L, et al. Mobile health solutions for atrial fibrillation detection and management: a systematic review[J]. Clinical Research in Cardiology, 2022, 111(5): 479-491. DOI:10.1007/s00392-021-01941-9.

[4] GUO Y T, WANG H, ZHANG H, et al. Mobile photoplethysmographic technology to detect atrial fibrillation[J]. Journal of the American College of Cardiology, 2019, 74(19): 2365-2375. DOI:10.1016/j.jacc.2019.08.019.

[5] CHEN Wanlan, HUANG Jiahui, SHI Ying, et al. Diagnostic performance of smartwatch ECG for detecting atrial fibrillation episodes in patients with different ventricular rates[J]. Chinese Journal of Cardiac Arrhythmias, 2022, 26(3): 277-282. DOI:10.3760/cma.j.cn113859-20211227-00113.

[6] YU Chao, ZHOU Wei, WANG Tao, et al. Research progress on wearable devices supporting screening and management of atrial fibrillation populations[J]. Chinese General Practice, 2023, 26(1): 113-117. DOI:10.12114/j.issn.1007-9572.2022.0449.

[7] MASON P K, LAKE D E, DIMARCO J P, et al. Impact of the CHA2DS2-VASc score on anticoagulation recommendations for atrial fibrillation[J]. American Journal of Medicine, 2012, 125(6): 603.e1-603.e6. DOI:10.1016/j.amjmed.2011.09.030.

[8] GIBBS H, FREEDMAN B, ROSENQVIST M, et al. Clinical outcomes in asymptomatic and symptomatic atrial fibrillation screening[J]. American Journal of Medicine, 2021, 134(7): 893-901.e11. DOI:10.1016/j.amjmed.2021.01.017.

[9] SGRECCIA D, MANICARDI M, MALAVASI V L, et al. Comparing outcomes in asymptomatic and symptomatic atrial fibrillation: a systematic review and meta-analysis of 81,462 patients[J]. Journal of Clinical Medicine, 2021, 10(17): 3979. DOI:10.3390/jcm10173979.

[10] ARONSSON M, SVENNBERG E, ROSENQVIST M, et al. Cost-effectiveness of mass screening for untreated atrial fibrillation using intermittent ECG recording[J]. Europace, 2015, 17(7): 1023-1029. DOI:10.1093/europace/euv083.

[11] KIRCHHOF P, BENUSSI S, KOTECHA D, et al. 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS[J]. European Heart Journal, 2016, 37(38): 2893-2962. DOI:10.1093/eurheartj/ehw210.

[12] HINDRICKS G, POTPARA T, DAGRES N, et al. 2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS): the Task Force for the diagnosis and management of atrial fibrillation of the European Society of Cardiology (ESC) Developed with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC[J]. European Heart Journal, 2021, 42(5): 373-498. DOI:10.1093/eurheartj/ehaa612.

[13] PÉRULA-DE TORRES L A, LUQUE-MONTILLA R, et al. Validation of taking arterial pulse in Primary Care for the detection of atrial fibrillation and other cardiac rhythm disorders in patients over 65 years old[J]. Semergen, 2017, 43(6): 425-436. DOI:10.1016/j.semerg.2016.06.015.

[14] ORCHARD J, LI J L, FREEDMAN B, et al. Atrial fibrillation screen, management, and guideline-recommended therapy in the rural primary care setting: a cross-sectional study and cost-effectiveness analysis of eHealth tools

to support all stages of screening[J]. Journal of the American Heart Association, 2020, 9(18): e017080. DOI:10.1161/JAHA.120.017080.

[15] LEE R, MITTAL S. Utility and limitations of long-term monitoring of atrial fibrillation using an implantable loop recorder[J]. Heart Rhythm, 2018, 15(2): 287-295. DOI:10.1016/j.hrthm.2017.09.009.

[16] LEE C T, STRAUSS D M, STONE L E, et al. Preoperative CHA2DS2-VASc score predicts postoperative atrial fibrillation after lobectomy[J]. Thoracic and Cardiovascular Surgery, 2019, 67(2): 125-130. DOI:10.1055/s-0038-1675638.

[17] WOJSZEL Z B, KASIUKIEWICZ A, SWIETEK M, et al. CHA2DS2-VASc score can guide the screening of atrial fibrillation - cross-sectional study in a geriatric ward[J]. Clinical Interventions in Aging, 2019, 14: 879-887. DOI:10.2147/CIA.S206976.

[18] YANG Hong, LIU Jun, FENG Zhigang, et al. Value of CHA2DS2-VASc score in screening for atrial fibrillation and ischemic stroke in community-dwelling elderly populations[J]. Chinese General Practice, 2021, 24(18): 2281-2284, 2290. DOI:10.12114/j.issn.1007-9572.2021.00.501.

Funding: Shanghai Pudong New Area Health Commission Health Fund (PW2022A-16)

Ethical Approval: Approved by the Medical Ethics Committee of Jinyang Community Health Service Center (JYKJ-2023-03)

Conflict of Interest: None declared

Received: September 15, 2023; **Revised:** November 25, 2023; **Accepted:** [Not specified]

Editor: JIA Mengmeng

Note: Figure translations are in progress. See original paper for figures.