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Improvement in Atrial Fibrillation Detection by Pulse Checking of Patients with Non-Cardioembolic Stroke in Rehabilitation Hospitals: The ESCORT Study

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Background: Rehabilitation therapists are sometimes unaware of the possibility of undiagnosed atrial fibrillation (AF) and the importance of AF detection. Thus, we aimed to increase awareness among rehabilitation therapists of the importance of AF detection at rehabilitation hospitals during regular pulse checks of patients with ischemic stroke.

Methods: In this multicenter prospective observational study, we enrolled patients with noncardiac stroke. The therapists performed pulse checks before, during, and after rehabilitation during the inpatient period. Electrocardiography (ECG) was performed to check for AF when arrhythmia or tachycardia was detected. The characteristics, ECG data, laboratory data, complications such as stroke recurrence, and functional outcomes of the patients were investigated.

Results: Among 158 included patients (97 [61.4%] men, median age 77 [interquartile range {IQR}, 71-84] years), the median stay in stroke centers was 21 (IQR,15-31) days. Regarding medication administered upon admission, 94 (59.5%) patients received single antiplatelet therapy and 14 (8.9%) patients received no antithrombotic medication. Electrocardiography and blood testing were performed on admission in 112 (70.9%) and 136 (87.3%) patients, respectively. The median hospitalization period in the rehabilitation center was 179 (IQR, 90-272) days. Four patients (2.5%) experienced recurrent events. No patients developed AF or palpitations.

Conclusions: Although our results suggest increased awareness of AF detection in rehabilitation centers, AF was not detected. AF detection using pulse checks alone may be challenging; thus, further investigation is warranted. (J Nippon Med Sch 2024; 91: 527–533)

Key words: atrial fibrillation, cryptogenic stroke, rehabilitation hospital, pulse check, multicenter study

Introduction

Detection of atrial fibrillation (AF) is critical for preventing recurrent stroke. Moreover, anticoagulant therapy is necessary to prevent recurrence in cases of AF[1,2], while antiplatelet agents are useful for preventing many other types of stroke, such as those caused by atherosclerosis or small-vessel disease[3,4].

Approximately 15-40% of strokes are considered cryptogenic, among which strokes with embolic mechanisms are defined as embolic strokes of undetermined source (ESUS)[5]. Anticoagulants do not show superior efficacy over antiplatelet agents in ESUS[6,7] or atrial cardiopathy[8].

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Therefore, indiscriminate use of anticoagulants for preventing recurrent stroke is not desirable; rather, AF should first be detected before appropriate anticoagulant administration for preventing recurrent stroke.

Detecting AF in the short term is often challenging, and incidence reportedly increases with long-term monitoring[9–11]. While screening for AF is generally conducted during hospitalization in stroke centers, recent progress in therapies such as mechanical thrombectomy has enabled early patient transfer to rehabilitation hospitals and reduced the duration of hospitalization in acute-care hospitals. In rehabilitation hospitals, the primary focus is on rehabilitation rather than AF detection, leading to fewer attempts to detect AF. In addition, rehabilitation therapists may not be sufficiently aware of the possibility of undiagnosed AF and the importance of AF detection. Consequently, early aggressive rehabilitation is feasible for functional improvement. However, in stroke centers, this may have reduced the time required for detecting AF and potentially lowered its detection rate.

To increase understanding of the importance of AF detection among rehabilitation therapists, this study investigated the timing and rate of AF detection in rehabilitation hospitals. Regular pulse screening was performed for AF detection. Implementation of regular pulse testing during rehabilitation may be feasible and effective for AF detection and could be recommended as a method for continued AF detection after discharge from stroke centers.

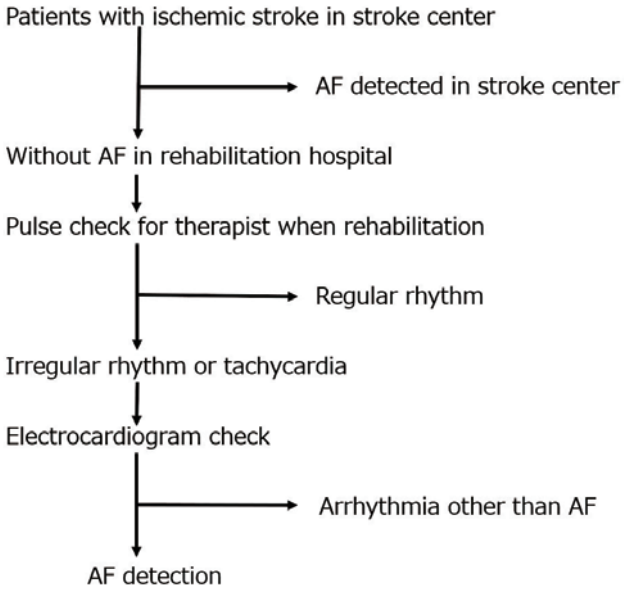

Fig. 1 Study design flowchart
Flowchart of the study design shows the sequence from stroke diagnosis at the stroke center to pulse and AF diagnosis at the rehabilitation hospital.
AF, atrial fibrillation.
Source: Katano T, Suda S, Ohta T, et al. Regular pulse checks for patients with non-cardioembolic stroke in rehabilitation hospitals to improve recognition and detection of atrial fibrillation (the ESCORT study): protocol for a prospective multicenter observational study. Front Neurol. 2023 Aug 16; 14: 1247020. © Takehiro Katano

Materials and Methods

Study Design and Ethical Approval

This observational, multicenter, prospective study enrolled patients with ischemic stroke treated at six rehabilitation centers in Japan between September 2022 and August 2023. This study, named the ESCORT study, aimed to improve recognition and detection of atrial fibrillation by assessing the effects of regular pulse checks in patients with non-cardioembolic stroke in a rehabilitation hospital. The study was approved by the ethics committee of Nippon Medical School (approval number: A-2021-067) and the relevant ethics committees of all participating centers.

Patient Population and Data Collection

The study participants were patients with stroke who had not been diagnosed with AF during their hospitalization in acute-care hospitals. The inclusion and exclusion criteria have been published previously[12] and are described in Supplementary Table 1. Written informed consent was obtained from all patients (or their family members) at each hospital before they participated in the trial. The detailed study data are shown in Supplementary Table 2. Data, including patient characteristics, electrocardiography data, laboratory data, hospital events, and discharge status, were obtained from the rehabilitation hospitals.

Evaluations

This evaluation method has been published previously[12]. **Figure 1** shows a flowchart of the study design. Pulse checks were performed for each patient by rehabilitation therapists before, during, and after rehabilitation sessions, usually three times per day (for a total of nine pulse checks daily). The pulse check proceeded as follows:

Preparation: Extend one wrist outward and turn the palm slightly upwards.

Positioning: Elevate the wrist slightly to identify the wrist creases.

Palpation: Place the tips of the index, middle, and ring fingers along the crease so that the ring finger aligns with the crease. Find the spot where the pulse is most

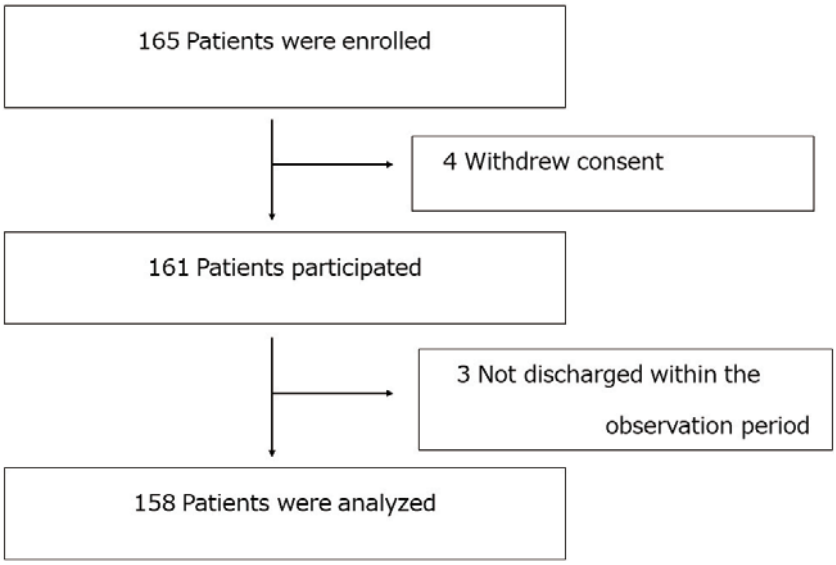

Fig. 2 Patient flowchart
Flowchart showing patient flow in the study.

palpable inside the bone at the base of the thumb.

Assessment: Gently lift the fingertips to better feel the pulse. Check the pulse for approximately 15 s to determine if it is regular. If the pulse seems irregular, continue monitoring for an additional 1-2 min. When an irregular pulse and tachycardia (heart rate of 120 beats/min or faster) were detected, a 12-lead electrocardiography (ECG) was immediately performed, and the doctors in the rehabilitation hospitals evaluated the patient for AF.

Data Analysis

We examined the characteristics of the study participants at admission and discharge. Categorical variables are presented as frequencies and percentages. All statistical analyses were performed using the SPSS software (version 27; SPSS Japan, Inc., Tokyo, Japan). The results were considered statistically significant at $P<.05$. Univariate analyses were performed using the χ^2 and Mann-Whitney U tests, as appropriate. Data are presented as medians and interquartile ranges, as described in the protocol paper[12].

Study Organization

The ESCORT study is led by a central coordinating center in the Department of Neurology at Nippon Medical School and is ongoing at six collaborating medical institutions in Tokyo, Japan.

Results

This study enrolled 165 patients. Four patients withdrew consent, and three patients were not discharged during the observation period. Therefore, the analysis included 158 patients. **Figure 2** shows the patient flowchart.

In the final study population, 97 patients (61.4%) were male, with a median age of 77 (IQR, 71-84) years and a median body mass index of 22 (IQR, 20-25) kg/m^2. The median hospital stay was 21 (IQR, 15-31) days in the stroke centers. A total of 26 patients (16.5%) had a Modified Rankin Scale (mRS) score of 0-2 upon admission. The baseline patient characteristics were as follows: hypertension was observed in 102 patients (64.6%), hyperlipidemia in 42 (26.6%), diabetes mellitus in 41 (25.9%), prior ischemic stroke/transient ischemic attack (TIA) in 51 (32.3%), prior hemorrhagic stroke in three (1.9%), prior cardiovascular disease in 13 (8.3%), deep vein thrombosis in eight (5.1%), and malignancy in 14 (8.9%); one patient had active cancer and 13 patients had non-active cancer (**Table 1**). According to the Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification, small-vessel disease was observed in 18 (11.4%) patients, large-artery atherosclerosis in 93 (58.9%), and other determined/undetermined etiologies in 47 (30.7%). On admission, single antiplatelet therapy was administered in 94 (59.5%) patients, dual antiplatelet therapy in 41 (25.9%), anticoagulant therapy in five (3.2%), antiplatelet and anticoagulant therapy in four (2.5%), and no antithrombotic medication in 14 (8.9%). All patients using anticoagulants had deep vein thrombosis. Recombinant tissue-type plasminogen activator was administered to seven patients (4.4%), and nine patients (5.7%) underwent mechanical thrombectomy as a treatment for acute stroke. ECG and blood tests were performed on admission in 112 (70.9%) and 136 (87.3%) patients, respectively. The median Functional Independence Measure (FIM) and Mini-Mental

Table 1 Baseline clinical characteristics

Variables	n=158
Male sex, n (%)	97 (61.4)
Age, median (IQR), years	77 (71-84)
Hospitalization period on stroke center, median (IQR), day	21 (15-31)
Modified Rankin Scale score 0-2 on admission, n (%)	26 (16.5)
Body weight, median (IQR), kg	58 (48-64)
Height, median (IQR), cm	160 (162-166)
Body Mass Index, median (IQR)	22 (20-25)
Medical history, n (%)	
Hypertension	102 (64.6)
Hyperlipidemia	42 (26.6)
Diabetes mellitus	41 (25.9)
Smoking	69 (43.7)
Prior ischemic stroke/TIA	51 (32.3)
Prior hemorrhage stroke	3 (1.9)
Prior cardiovascular disease	13 (8.3)
Deep vein thrombosis	8 (5.1)
Malignancy	14 (8.9)
Active cancer	1 (0.6)
Non-active cancer	13 (8.3)
TOAST classification, n (%)	
Small-vessel disease	18 (11.4)
Large-artery atherosclerosis	93 (58.9)
Other determined/undetermined etiology	47 (30.7)
Medication on admission, n (%)	
Single antiplatelet therapy	94 (59.5)
Dual antiplatelet therapy	41 (25.9)
Anticoagulant therapy	5 (3.2)
Antiplatelet and anticoagulant therapy	4 (2.5)
No antithrombotic medication	14 (8.9)
rt-PA, n (%)	7 (4.4)
Mechanical thrombectomy, n (%)	9 (5.7)
Electrocardiogram on admission, n (%)	112 (70.9)
Atrial premature contraction, n (%)	5 (3.2)
PR interval, median (IQR), ms	0.17 (0.15-0.19)
QTc interval, median (IQR), ms	0.41 (0.40-0.43)
Blood test on admission, n (%)	136 (87.3)
Creatinine, median (IQR), mg/dL	0.8 (0.7-1.0)
C-reactive protein, median (IQR), mg/dL	0.3 (0.1-1.9)
Brain natriuretic peptide, median (IQR), pg/dL	21 (9-51)
N-terminal pro-brain natriuretic peptide, median (IQR), pg/dL	140 (76-281)
D-dimer, median (IQR), mg/dL	1.5 (0.8-2.8)
Functional Independence Measure on admission, median (IQR)	57 (33-78)
Mini-Mental State Examination on admission, median (IQR)	25 (18-28)

TOAST: Trial of Org 10,172 in Acute Stroke Treatment, IQR: interquartile range, TIA: transient ischemic attack

State Exam (MMSE) scores were 57 (IQR, 33-78) and 25 (IQR, 18-28), respectively (**Table 1**).

Clinical characteristics at the time of discharge are shown in **Table 2**. None of the patients in this study experienced AF or palpitations as subjective symptoms. The median hospitalization period in the rehabilitation center was 179 (IQR, 90-272) days. The median FIM and MMSE scores were 97 (IQR, 64-116) and 25 (IQR, 21-29), respectively. Recurrent events were reported in four patients (2.5%): three patients experienced ischemic events and one had a hemorrhagic event. A total of 77 patients (48.7%) patients had an mRS score of 0-2 at discharge.

Table 2 Clinical characteristics at discharge

Variables	n=158
Palpitations	0 (0.0)
Detection of atrial fibrillation, n (%)	0 (0.0)
Duration of hospitalization at rehabilitation center, median (IQR), days	179 (90-272)
Functional Independence Measure at discharge, median (IQR)	97 (64-116)
Mini-Mental State Examination at discharge, median (IQR)	25 (21-29)
Recurrent event, n (%)	4 (2.5)
Ischemic event, n (%)	3 (1.9)
Hemorrhagic event, n (%)	1 (0.6)
Modified Rankin Scale score 0-2 at discharge, n (%)	77 (48.7)

IQR, Interquartile Range

Discussion

In this study, pulse checking was used to improve awareness of the importance of AF detection in rehabilitation hospitals. Although AF was not detected in any patient in this study, rehabilitation therapists at the participating facilities were able to understand the need for AF detection and how to perform pulse checks.

AF is common and its prevalence increases with age[13,14]. Because AF increases the risk of cardioembolic stroke[15], which can lead to severe ischemic stroke[16], early detection and countermeasures are important. Moreover, AF causes cryptogenic strokes or ESUS[9–11]. Furthermore, AF was detected in 12.1% of patients with large-artery atherosclerosis or small-vessel occlusion within 1 year of using an insertable cardiac monitor (ICM)[17]. This report suggests that, with adequate testing, AF detection is possible in non-cardiogenic stroke. A long-term survey reported an improvement in the AF detection rate for stroke patients[9–11]. Therefore, we considered the possibility that AF may be detected in patients diagnosed with non-cardiogenic stroke. Because rehabilitation hospitals typically do not perform active AF detection, we improved awareness of the importance of AF detection in such hospitals and investigated AF detection in post-stroke centers.

The present results illustrate the reality in rehabilitation hospitals. Large-artery atherosclerosis was the most common cause of stroke, whereas small-vessel occlusion was the least common cause of stroke among the study participants. These results reflect the severity of the need for rehabilitation in each type of stroke. Improvements were observed in FIM, MMSE, and mRS scores during the observation period. The results also indicate that this study involved standard rehabilitation procedures and that rehabilitation was effective after stroke, consistent with previous reports[18–20]. We also found that only 70% of patients in the rehabilitation hospitals underwent ECG assessment on admission. This result may be attributable to the assumption that various examinations are performed at stroke centers, which may also indicate limited awareness of AF detection in rehabilitation hospitals. We believe that the importance and methods of AF detection were understood by the present rehabilitation therapists and that AF detection was performed appropriately.

We used pulse checking to detect AF because it is convenient and can be performed by anyone, anytime, anywhere, and without other equipment. The Japanese Arrhythmia Guidelines recommend the Class 1 method for AF screening[21], and the use of a smartwatch for pulse check reportedly identified AF[22].

No AF was detected in participants with stroke. Although a sustained pulse check using an ICM or smartwatch allows for effective AF detection, temporary examinations may pose challenges. In this survey, we performed pulse checks only nine times daily. Another reason for the lack of detection is the limited duration of observation. The median observation duration in this study was approximately 6 months. In the STROKE-AF study, which also had a 6-month observation period and utilized non-ICMs, AF was detected in only 0.8% of the patient population[17]. Similarly, in the CRYSTAL-AF study with a 6-month observation period and non-ICM detection methods, AF was detected in only 1.4% of the patient population[9]. Other reports have suggested that a longer observation period improves detection rates[10,11]. However, this study was conducted during hospitalization in a rehabilitation hospital with the aim of enhancing awareness of AF detection and conducting continued AF surveillance. We believe that the study fulfilled its stated aim.

Future efforts highlighting the significance of AF detection across facilities should focus on encouraging sus-

tained effort in AF detection. The AF detection rate could be improved by identifying patients at high risk of AF in stroke centers and sharing this information with rehabilitation hospitals by including not only pulse checks but also regular ECG examinations.

The limitations of this study include its small sample size; the overlap of the coronavirus disease pandemic with the planned research period may have hindered our ability to recruit the anticipated number of participants. A larger sample size might have allowed for detection of AF. Second, the observation period in this study was short; however, it is inherently limited in rehabilitation hospitals in Japan. Third, it is unclear how many patients with ESUS were included because this study used the TOAST system for stroke classification. ESUS patients may also have a high incidence of occult AF; thus, inclusion of many ESUS patients could have led to detection of AF.

In this ESCORT study, AF was not detected in patients with noncardiac stroke. However, continued attempts to detect AF are needed to prevent recurrent stroke in the future.

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