

The Significance of Detective Arrhythmia by Using the Long- Term Ecg Monitoring in the Elderly “so Called” Healthy People: A Screening Study

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Abstract

Background

Arrhythmias are potential harmful diseases to human beings, especially atrial fibrillation and ventricular arrhythmia, for causing serious consequences such as acute stroke or even sudden cardiac death. Recently the screening of asymptomatic atrial fibrillation by using the long-term ECG monitoring has been widely noticed. The study is to evaluate the significance of detecting arrhythmia by using the long-term ECG monitoring in the elderly “so called” healthy people who never have the symptoms of palpitation, short breath or deny previous history of arrhythmia.

Methods

We enrolled a screening study of 1056 participants who were the elderly “so called” healthy people and ready to have a healthy examination from three different communities. They all underwent a long-term ECG monitoring—an adhesive patch—to evaluate cardiac arrhythmia. Inclusion criteria were 1) without any symptoms, 2) age ≥ 55 , and 3) denying previous history of arrhythmia. We excluded patients with prior arrhythmias and who carried the patch for less than one day due to various factors. Then we compared the detected arrhythmia events in the first 24 hours and the total wearing time.

Results

Out of 1056 participants (69.8 \pm 12.0 years, 620 males), supraventricular tachycardia (SVT) was present in 538 subjects (44% VS 54%, 24 hours VS after 24 hours, $P > 0.05$), atrial fibrillation (AF) was detected in 69 subjects (75% VS 25%, 24 hours VS after 24 hours, $P < 0.001$), second degree type II atrioventricular block/third degree atrioventricular block (AVB) and sinus arrest were detected in 9 subjects (22% VS 78%, 24 hours VS after 24 hours, $P < 0.001$), ventricular tachycardia was detected in 29 subjects (31% VS 69%, 24 hours VS after 24 hours, $P < 0.001$). The adhesive patch monitor detected 32.10% (339/1056) arrhythmia events over the first 24 hours compared with arrhythmia events over the total wearing time of the devices, 61.08% (645/1056) ($P < 0.001$).

Conclusions

The long-term adhesive patch monitor (APM) can improve the diagnosis of concealed arrhythmias which have high risks for life quality and lifespan in the elderly “so called” healthy people, and the diagnostic advantage in bradycardia and ventricular arrhythmias are more obvious.

Introduction

Cardiac arrhythmias are often asymptomatic and associated with serious adverse outcomes [1]. Cardiac arrhythmias, such as atrial and ventricular arrhythmias and atrioventricular block, are associated with critical adverse outcomes, such as congestive heart failure, stroke and sudden cardiac death [2]. Atrial fibrillation (AF), which is the most common sustained cardiac arrhythmia, is highly associated with

embolic stroke, leading to heavy economic burden to the patients [3]. In most countries, people choose to visit doctor for some symptoms. However, most people don't visit doctor if they do not have symptoms. This part of people are "so called" healthy people.

Electrocardiogram (ECG) and the Holter monitor are the most commonly used methods in routine medical checkups for screening arrhythmias in patients outpatient or inpatient. Although the traditional Holter records continuously for 24 hours, the equipment is expensive, resulting in a high procurement threshold for medical institutions and a limited diagnostic opportunities. The 24-hour 12-lead Holter monitor with many lead patches usually has the shortness of discomfort and limiting patient activities, limiting its monitoring for a long period of time (seven or fourteen days) [4]. But the ECG also often misses to capture events due to short recording time. We have less few chances to monitor "so called" healthy people who never have the symptoms of palpitation or shortbreath or deny previous history of arrhythmia if they don't go to hospital. If the arrhythmia do not occur within 24 hours of the detection time, the arrhythmia of the culprit could not be detected by the 24-hour Holter monitor, leading to the miss of subclinical arrhythmia [5]. In addition, implantable loop recorders (ILR) can also be used to detect the cause of recurrent syncope, but its application is limited due to cost and surgical problems [6-7].

Some of the "so called" healthy people could be hospitalized for sudden acute events, such as syncope, stroke or heart attack due to the low rate of seeking medical care and diagnosis, resulting in serious consequences. Obviously, earlier use of noninvasive methods to detect arrhythmia, such as AF, ventricular tachycardia and atrioventricular block could reduce medical and financial burdens, especially for the elderly. Adhesive patch monitor can detect more arrhythmias than traditional Holter monitor [8-9]. We aimed to evaluate the feasibility of using the adhesive patch monitor for diagnosing cardiac arrhythmias in the elderly "so called" healthy people.

Methods

Study design

The enrolled participants referred to be the elderly "so called" healthy people respectively from Heilongjiang Province Rong Yu Jun Ren Kang Fu Hospital, Rongshi Community Hospital and retired workers from the First Affiliated Hospital of Harbin Medical University between January 2017 to March 2019 who underwent health examination . After medical history inquiry and physical examtation, the participants were asked to wear the adhesive patch monitor (Shanghai Yueguang Medical Technology Co., LTD 中国上海 machinery note20162210201) for 7 days. The study was approved by the Institutional Review Board (IRB) of the First Affiliated Hospital of Harbin Medical University.

The inclusion and exclusion criteria of the study are as follows: all participants included in the study were more than 55 years old; asymptomatic or deny previous history of arrhythmia; informed consent to carry a long-term adhesive patch monitor for 7 days. We excluded participants having symptoms (shortness of breath and palpitation etc) and participants with a history of atrial fibrillation/flutter, supraventricular tachycardia (SVT), II type II atrioventricular block, three degree atrioventricular block, sinus arrest > 2.5 s,

ventricular tachycardia, polymorphic ventricular tachycardia and ventricular fibrillation; history of cardiac electronic device implantation or skin allergic reaction.

Arrhythmia events

Clinically, significant arrhythmias were defined as (1) sinus pause >2 s; (2) symptomatic bradycardia <40 b.p.m.; (3) second-degree (and higher) AV block, complete AV block; (4) ventricular fibrillation; (5) sustained/nonsustained VT (>3 beats); (6) atrial fibrillation (chronic or paroxysmal); (7) atrial flutter and SVT >120 b.p.m (last \geq 30s).

Data collection

The Yueguang patch-based device (Figure 1) can record up to 15-30 days of uninterrupted monitoring on a single vector. They were asked to wear the monitoring device for up to about 7 days and then sent it back to the hospital to analyse the data. The participant's medical records were summarized by investigators. The study was reviewed by the local government's approval consent and carried out as Helsinki declaration required. After they sent the monitor back for data analysis, a report was generated. Finally, we summarized the data, analyzed the incidence and characteristics of arrhythmia and detected the cumulative rate of arrhythmia. Baseline characteristics including demographics, medical history and health behaviors were abstracted from the patient medical record by 2 trained investigators (Table1). The study was approved to collect the data from the Rong Yu Jun Ren Kang Fu Hospital and Rongshi Community Hospital.

Statistical Analysis

Proportions and means were compared using the χ^2 test and t test with unequal variance, respectively. *P* values <0.05 were considered significant. All analyses were performed using STATA software version 11.0 (StataCorp, College Station, TX).

Results

Demographics

We enrolled 1087 participants, a total of 1056 participants (69.8 \pm 12.0 years, 620 males) to complete the monitoring. Among the subjects who did not complete the monitoring, 31 participants were disqualified because of the allergy or discomfort of the patch and stopped wearing the device prior to the date (Figure 2). The baseline characteristics of 1056 participants who completed the monitoring were shown in Table 1 (medical history statistics), and the wearing time was 4.38 \pm 2.26 days. Among 1087 subjects, there were 909 participants coming from Heilongjiang Province RongYuJunRenKangFu Hospital, 130 participants from the Rongshi Community Hospital and 17 retirees from the First Affiliated Hospital of Harbin Medical University (Figure 2).

Detection of arrhythmia

Detected arrhythmia events during monitoring are shown in Table 2. Overall, the adhesive patch monitor detected 61.08% (645/1056) arrhythmia events over the total wearing time of the devices, compared with 32.10% (339/1056) arrhythmia events over the first 24 hours ($P < 0.001$). We found that there were 276 subjects of supraventricular tachycardia recorded, 52 subject of atrial fibrillation/flutter, 1 subject of second degree type II atrioventricular block/ third degree atrioventricular block, 1 subject of sinus arrest, 9 subjects of ventricular tachycardia and ventricular fibrillation (0 subject of ventricular fibrillation) in the first 24 hours. The diagnostic advantage in bradycardia (22% VS 78%, 24 hours VS after 24 hours, $P < 0.001$) and ventricular arrhythmias (31% VS 69%, 24 hours VS after 24 hours, $P < 0.001$) are more obvious in long-term adhesive patch monitor (APM) data (Figure 3). The episode of AF was defined as the lasting time ≥ 30 seconds of during monitoring.

All episodes of cardiac arrhythmias recorded were detected in 538 subjects of supraventricular tachycardia, 69 subjects of atrial fibrillation/flutter, 5 subject of second degree type II atrioventricular block/third degree atrioventricular block, 4 subjects of sinus arrest, 29 subjects of ventricular tachycardia/ventricular fibrillation (0 subject ventricular fibrillation) in the overall time. In addition to supraventricular tachycardia, the rest four types of arrhythmias (Atrial fibrillation, conduction block, sinus arrest, ventricular tachycardia) recorded in the first 24 hours and the overall time were 5.97% [63/1056] and 10.13 % [107/1056] respectively (Table 2).

Detection of AF

AF was detected in 69 subjects (6.53%) [52 of 69 subjects who were detected with AF had ≥ 1 episode in the first 24 hours, and 17 of 69 subjects were detected after the first 24 hours of monitoring. Moreover, 32 of 69 subjects experienced paroxysmal atrial fibrillation and 37 of 69 subjects experienced persistent atrial fibrillation (Table 2). AF was detected in 61/909 people in the Heilongjiang Province RongYuJunRenKangFu Hospital: 27 patients experienced chronic AF and 34 patients experienced paroxysmal AF. AF was detected in 6/130 people in the Rongshi Community Hospital: 1 patient experienced chronic AF and 5 patients experienced paroxysmal AF. Moreover, 2/17 retirees were experienced chronic AF in The First Affiliated Hospital of Harbin Medical University.

Three sample ECG strips are been respectively shown, exhibiting episodes of AF (Figure4 A), sustained SVT that was determined to be AT (Figure4 B), and NSVT (Figure4 C) detected in separate study participants.

Wearing the adhesive patch for an average 4.38 ± 2.26 days, the time distribution of appeared arrhythmia is shown in Figure 5, the discovery of arrhythmia ratio is 33.21% in the first 24 hours. As the extension of wearing time, the proportion of arrhythmia increased (44.88%, 49.01%, 51.89%, 53.50%, 53.68%, 54.04%), and until the seventh day, detection of arrhythmia events amount 20.83% increase from the previous 24 hours. The second day had the highest increase over the first day, with an increase of 11.57%.

Discussion

Cardiac arrhythmias are often difficult to detect even though in most symptomatic patients, because patients are usually asymptomatic, leading to substantial mortality. The long-term adhesive patch ECG monitoring device is recently widely used for detecting AF, especially using in the screening of asymptomatic AF. Therefore, our study focused on the long-term ECG monitoring in asymptomatic patients in order to detect all kinds of arrhythmias in the elderly “so-called” healthy people and improve the screening and diagnostic rates [10-11].

We found that 6.53% participants had atrial fibrillation in the range of adhesive patch monitoring detection in our study. Furthermore, a high prevalence of 50.95% (538/1056) of participants with supraventricular tachycardia was monitored. These results confirm that targeted screening of asymptomatic atrial fibrillation and supraventricular tachycardia is feasible and has clinical diagnostic value. Since the asymptomatic arrhythmia is 30% [12], which is roughly consistent with our test data in the first 24 hours (32.10%). The traditional screening approach is standard ECGs or Holter monitoring devices, but the adhesive patch device is more suitable for recording asymptomatic arrhythmias; the longer the monitoring time, the more morbidity will be found (61%). The difficulty in screening for AF is that it is paroxysmal and asymptomatic, correlated with thromboembolic events. Therefore, it is quite important to initiate anticoagulant therapy considering the patients' risks, the duration and burden of AF and other factors [13]. SVT's therapy or intervention is also considered for its importance to select the suitable strategy. Because shorter episodes of atrial tachycardia can act as a precursor for atrial flutter and atrial fibrillation, early treatment for atrial tachycardia may be beneficial in preventing atrial fibrillation. Therefore, it is necessary for patients with atrial arrhythmia to follow up or even hospitalized.

ECG and the 24-hour Holter monitor are common ways to screen outpatients or inpatients for arrhythmia, especially in those who have symptoms. 24-hour Holter extends the scope of detection beyond ECG but it may also miss events and limit patient activity [14-16]. A systematic review showed that undiagnosed AF has a rate of 1.0% in the general population (n=67,772) [17]. Therefore, our experiment focuses on the adhesive patch that can provide longer monitoring time and convenience. Moreover, it makes the patients find the adhesive patch more comfortable to wear. It improves feasibility of wearing this device longer time, making us to obtain more data about arrhythmias.

Screening for atrial fibrillation is related to the age of enrollment, health status and detection time. The younger the age, the fewer risk factors in the medical history and the shorter the monitoring time, the lower the screening rate is [18-19]. Our baseline data included age, sex, heart failure, hypertension, diabetes and stroke. We found an increase in AF events as the duration of detection lengthened in Table 2, which has significant implications for screening atrial fibrillation. We told some patients that they had atrial fibrillation and might need anticoagulant therapy, but there was no follow-up. Further follow-up would be better for the treatment of these patients. The earlier the diagnosis of atrial fibrillation is, the more vital it is for patients to initiate anticoagulant therapy in order to prevent thromboembolic events. Previous studies have showed that patients with previous embolic events had a high rate of AF detection rates, showing that the stroke can be the first clinical event of AF [20-25]. Therefore, we should focus on

screening people with high risk factors in their medical history, who are the elderly “so called” healthy people and strengthen their follow-up in the future.

Our study demonstrated high diagnostic yield using the long-term ECG monitoring in arrhythmias. Many studies have found that long-term monitoring detected more arrhythmias than conventional Holter [8-9]. In our study, the rate of detected arrhythmias is 20.83% more than in the first 24 hours, indicating that the clinically meaningful arrhythmia event rates detected increasingly by which could be found in using 24h Holter in the elderly “so called” healthy people in the first 24h. Therefore there is also the need for long-term monitoring to detect more events of arrhythmias after the first 24hrs. AF screening and stroke prevention are becoming more instructive through multi-center studies. In our study, 17 of 69 patients experienced the episode of AF after the first 24 hours of monitoring (Table 2), so the advantages and necessity of the adhesive patch is obvious. If patients do not continue to wear the patch or use routine Holter, they will not be screened for atrial fibrillation or other arrhythmias, so some people may miss the opportunity to initiate anticoagulation and even may have embolism or other sudden cardiac death events. The next important step is that when detecting for atrial fibrillation, we need to contact patients and recommend outpatient or hospitalization. Then, according to the specific situation, grasp the timing of anticoagulation and avoid the harm of stroke is one of the research significances of this experiment. In addition to anticoagulation and rhythm control treatment for atrial fibrillation, upstream treatment, such as blood pressure and blood lipid control, should not be ignored. Our experimental group is currently studying the screening for arrhythmia in the elderly to evaluate arrhythmia, which is conducive to early treatment and early intervention in anticoagulation, so as to reduce the future economics and mental burden of family and society.

For the patients with ventricular tachycardia or supraventricular tachycardia, it is necessary to recommend hospitalization for further diagnosis, and if confirmed, according to Guidelines and combining with patient’s individual willingness, the pharmacological therapy or radiofrequency ablation can be recommended for treatment. If a high degree of conduction block is found, a pacemaker is recommended. In our study, one patient had completed pacemaker placement in our hospital after follow-up and recommended hospitalization. Also, another patient who was diagnosed sustained ventricular tachycardia had undergone radiofrequency ablation. In our study, the number of hypertensive patients was as high as 32.56%, indicating the necessity of screening for arrhythmia in hypertensive patients. Moreover, hypertension is a risk factor for AF and induces cardiac inflammation.

Conclusion

The long-term adhesive patch monitor can improve the diagnostic yield of undiagnosed arrhythmias in asymptomatic people who are the so-called healthy people, more arrhythmias could be detected with longer wearing time in our study, especially for bradycardia and ventricular arrhythmias. The patch monitor can accurately estimate rates of arrhythmias, contributing to early diagnosis, early interventions and avoiding harmful attained results.

Abbreviations

ECG: Electrocardiogram; SVT: supraventricular tachycardia; AF: atrial fibrillation; AVB: atrioventricular block; APM: adhesive patch monitor; ILR: implantable loop recorders

Declarations

Ethics approval and consent to participate

This study has been approved by the ethics committee of the First Affiliated Hospital of Harbin Medical University, and all the experimental protocol for involving humans was in accordance with guidelines of the Declaration of Helsinki. Informed consent was obtained from the patients.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

(I) Conception, design and Manuscript writing:RX, SH, YL and ZL; (II) Administrative support: YL, ZL; (III) Provision of study materials or patients: JZ, LG, SG and GG; (IV) Collection and assembly of data: SG, YX, MD, JL; (V) Data analysis and interpretation: RX, SH; (VI) Final approval of manuscript: All authors.

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Tables

Table 1. Baseline Characteristics (N=1056)

Characteristic	Value ^a	The percentage
Age, y	69.8±12.0	
Male sex	620	58.71%
CHF	53	4.75%
Hypertension	363	32.56%
Age ≥75years	342	30.67%
DM	107	9.60%
Stroke	244	21.88%

Abbreviations: CHF, congestive heart failure; DM, diabetes mellitus. Data are presented as mean±SD or n(%).

Table 2. Detected arrhythmia events during the long-term adhesive patch monitor

Arrhythmia type	First 24 hours	The overall time after 24 hours	P
Supraventricular tachycardia	276	538(262)	0.001
Atrial fibrillation	52	69(17)	0.001
Paroxysmal AF	15	32(17)	
Persistent AF	37	37(0)	
Bradycardia	2	9(7)	0.001
Conduction block	1	5(4)	
Sinus arrest	1	4(3)	
Ventricular tachycardia	9	29(20)	0.001

Note: interior percentage, Atrial fibrillation=Paroxysmal AF+Persistent AF, Bradycardia = type II atrioventricular block + type III atrioventricular block+sinus arrest.

Figures



Figure 1

The Yueguang patch-based device (Yueguang Technologies, Inc, Shanghai, China)

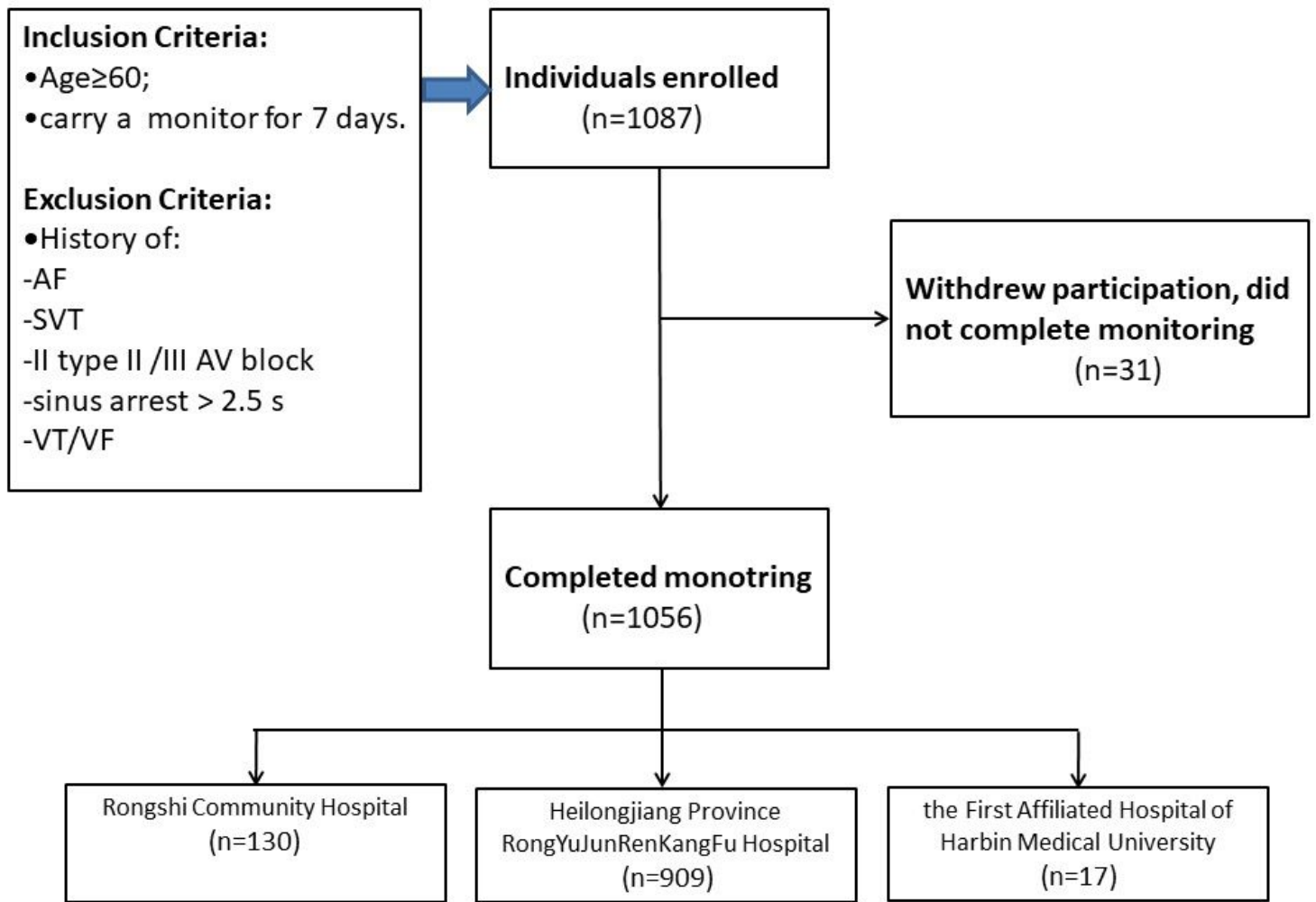


Figure 2

The study flow chart shows detailed inclusion and exclusion criteria for study participation and completion. Abbreviations: AF, atrial fibrillation; SVT, supraventricular tachycardia; VT/VF, ventricular tachycardia and ventricular fibrillation.

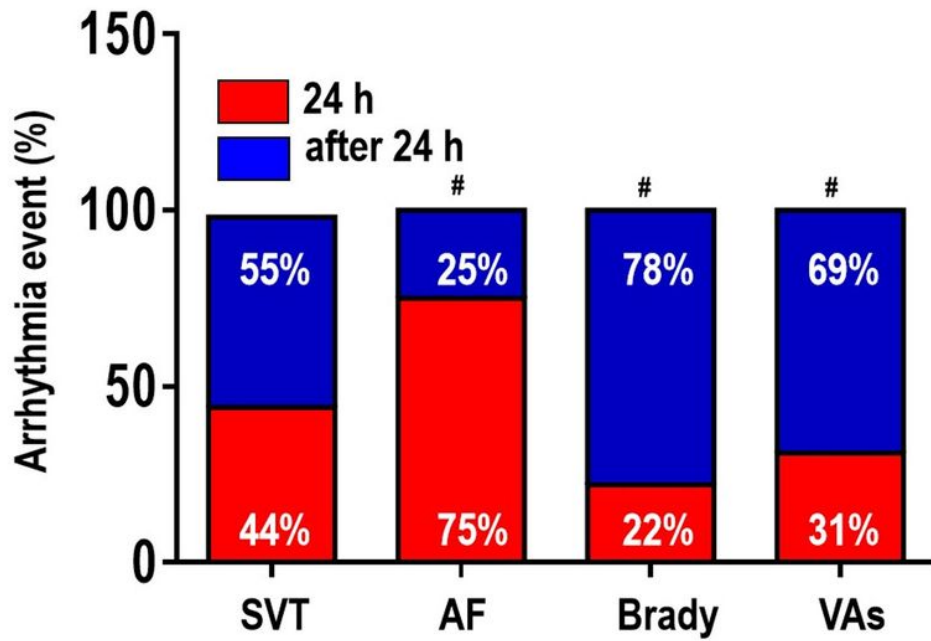


Figure 3

Compared the detected arrhythmia events at the 24 hours and after 24 hours during the long-term adhesive patch monitor. Note: # 24 hours VS after 24 hours $P < 0.001$

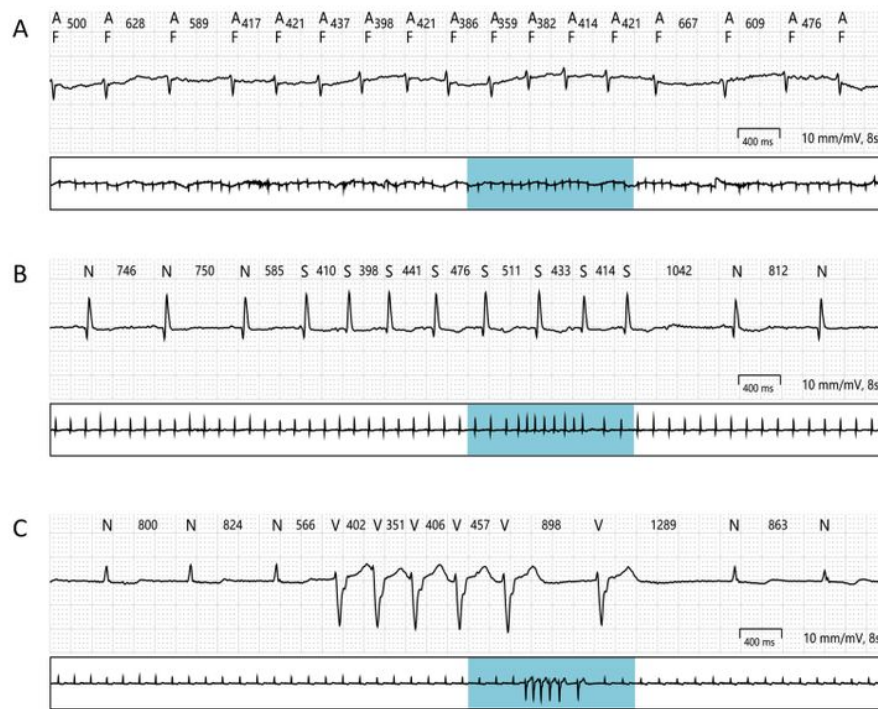


Figure 4

Three sample ECG strips are shown, exhibiting episodes of AF (A), sustained SVT that was determined to be AT (B), and NSVT(C) detected in separate study participants.

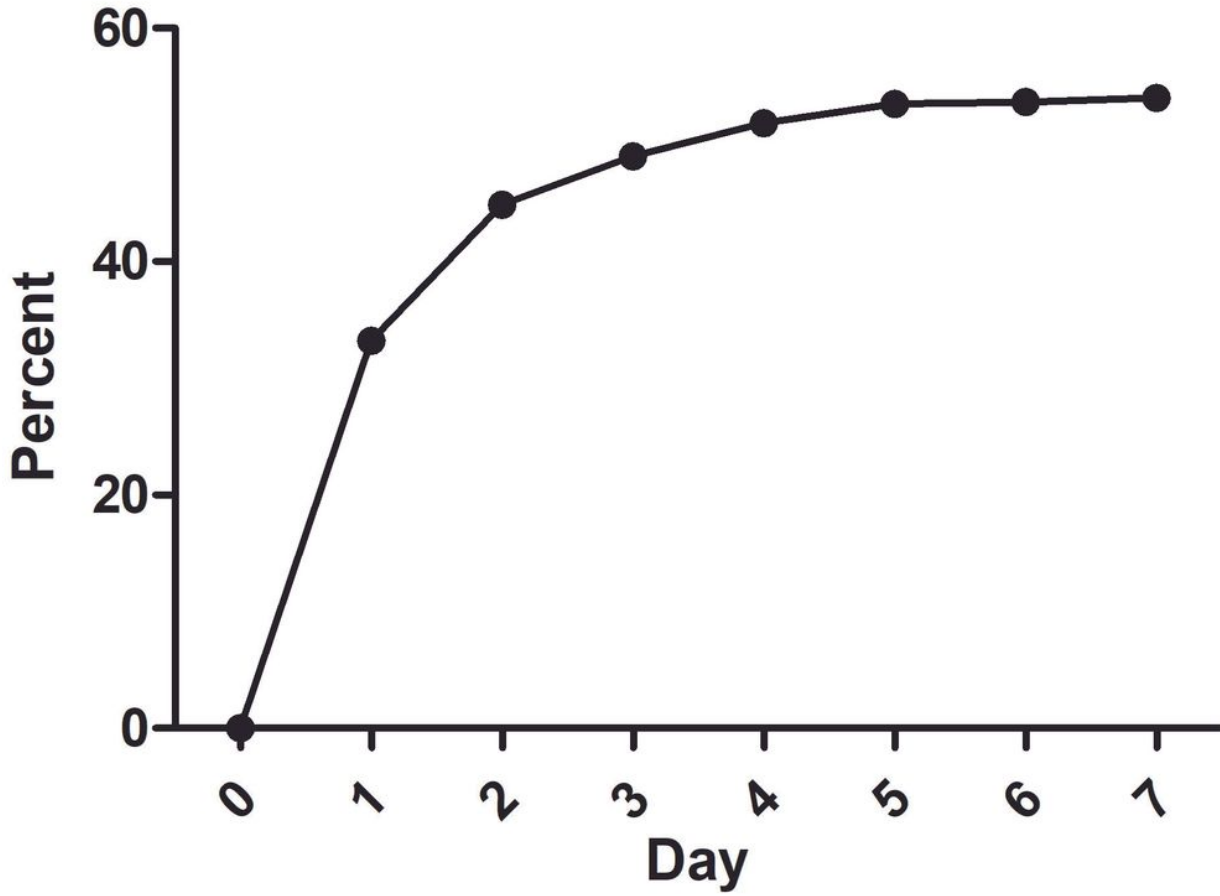


Figure 5

Cumulative rate of arrhythmia detection. With the extension of wearing time, the proportion of arrhythmias detected for the first 24 hours was 33.21%, and the number of arrhythmias detected on the seventh day was 54.04%, up 20.83% from the previous 24 hours.