## Atrial fibrillation with symptoms other than palpitations: incremental diagnostic sensitivity with at-home tele-cardiology assessment for emergency medical service


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*European Journal of Preventive Cardiology* 2012 19: 306 originally published online 18 April 2011
DOI: 10.1177/1741826711406060

*Original scientific paper*

European Journal of Preventive Cardiology

European Journal of Preventive Cardiology
19(3) 306–313

DOI: 10.1177/1741826711406060
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# Atrial fibrillation with symptoms other than palpitations: incremental diagnostic sensitivity with at-home tele-cardiology assessment for emergency medical service

**Natale Daniele Brunetti[1], Luisa De Gennaro[1], Pier Luigi Pellegrino[1], Giulia Dellegrottaglie[2], Gianfranco Antonelli[3] and Matteo Di Biase[1]**

## Abstract

**Background:** Clinical presentation of atrial fibrillation (AF) is usually represented by palpitations; nevertheless, atypical presentation of AF with symptoms other than palpitations may be not uncommon in elderly patients. This study therefore aimed to evaluate incremental diagnostic value of tele-medicine at-home assessment in patients who called emergency medical service (EMS).

**Methods:** A total of 27,841 consecutive EMS patients referred for suspected heart disease underwent ECG assessment with a mobile ECG-recorder device. ECGs were transmitted with mobile-phone support to a tele-cardiology 'hub' active 24/7 where a cardiologist read the ECGs. Rate of prevalence of AF, age of patients, and symptoms were analysed.

**Results:** AF was diagnosed in 11.67% of patients who underwent ECG examination. Typical symptoms were complained by 6.56% of whole patients, only 14.05% of patients with AF: rate of subjects with AF and typical symptoms significantly decreased with age (<65 years 29.58%, 65–75 years 17.06%, >75 years 10.35%, $p < 0.001$). Number needed to diagnose an AF with atypical presentation (number needed to treat) decreased from 45 (<65 years) to 9 (65–75 years) and 5 (>75 years) ($p < 0.001$). Tele-cardiology support increased the rate of at-home diagnosis of AF from two-fold (in 40-year-olds) up to four-fold (60-year-olds) and seven-fold (70-year-olds).

**Conclusions:** AF with symptoms other than palpitations is a common finding in elderly EMS patients. Tele-cardiology support improves the sensitivity of diagnosis of AF in elderly EMS patients and is useful in at-home identification of subjects with AF and atypical presentation.

**Keywords**
Atrial fibrillation, elderly, emergency medical service, tele-cardiology

Received 19 December 2010; accepted 15 March 2011

## Background

Atrial fibrillation (AF) is the most common cardiac rhythm disturbance; it is associated with significant morbidity and is responsible for a significant consumption of healthcare resources.[1] Prevalence of AF increases with age, with a median age of 75, a prevalence of 2.3% in patients older than 40 years and approximately 6% in patients older than 65 years.[2] Approximately 70% of individuals with AF are between 65 and 85 years of age.[2,3] Advanced age is also a potent risk factor for stroke in patients with AF, and the proportion of strokes attributable to AF increases exponentially with age.[3]

[1]Cardiology Department, University of Foggia, Foggia, Italy.
[2]Cardio-on-line Europe S.r.l., Bari, Italy.
[3]Cardiology Department, Azienda Ospedaliera Policlinico, Bari, Italy.

**Corresponding author:**
Natale Daniele Brunetti, Cardiology Department, University of Foggia, Foggia, Italy
Email: nd.brunetti@unifg.it

Many patients with AF have symptoms; however, a significant proportion of patients may have no symptoms, a condition referred to as silent or asymptomatic AF.[4] The reported incidence of silent AF depends on the monitoring frequency and the burden of AF on the cohort studied.[5] Symptoms are more likely to occur in patients who are younger, have higher ventricular response during AF, and who are female.[6]

Symptoms cannot be therefore relied upon and AF diagnosis may not be easy without immediate ECG support. In spite of this, at-home prompt diagnosis of cardiac arrhythmias is crucial in reducing delay to treatment and cardiovascular mortality in patients calling emergency medical service (EMS).

Tele-cardiology may represent a reliable support in avoiding wrong diagnosis and reducing delay to diagnosis, by providing a prompt at-home ECG analysis. Prior evidences are available in EMS patients with suspected acute myocardial infarction (AMI);[7] tele-cardiology at-home assessment significantly increased accuracy of diagnosis in elderly patients with ST-elevation AMI and atypical presentation.[8]

We therefore aimed to evaluate in this study whether at-home ECG evaluation with tele-cardiology support may reduce missed diagnosis of AF in EMS patients.

## Methods

This tele-cardiology program involved 27,841 patients from all over Apulia (19,362 $km^2$, 4 million inhabitants, south-western Italy), who called EMS '118' between October 2004 and April 2006. '118' is a free EMS for general either medical or surgical emergencies, whose aim is an immediate diagnosis of critical diseases, in order to avoid emergency room delay-to-diagnosis. Final hospitalization is disposed by crews' physicians and '118' district central, connected by mobile phone: direct admission to critical care unit is arranged according to level of care. Patients are discharged from the ambulance and not transported at all in case of normal findings. According to Italian legislation, '118' crews usually include a physician skilled in emergency medicine and/or nurses.

All crews of regional '118' EMS ($n = 154$) were equipped with apposite devices for recording and telephone transmission of 12-lead ECG (CardioVox P12 heart-line receiving system by Aerotel, Holon, Israel); the device does not show ECG records so the ECG cannot be immediately seen by 118 crews members (paramedics and physicians). Data recorded by '118' crews were immediately transmitted by mobile phone to a hub centre, operative 24/7) where a cardiologist promptly read the ECG. Logistic support for hub centre was furnished by Cardio-online Europe S.r.l.; about 20 cardiologists cooperated with Cardio-on-line Europe S.r.l. by providing cardiological consultancy.

Indications for ECG recording were presence of chest pain or epigastric pain, breathlessness, palpitations, loss of consciousness, or any suspected acute cardiovascular disease. After ECG recording, mobile telephone transmission, and ECG diagnosis, '118' district central disposed for hospitalization, when necessary.

AF was diagnosed according to current guidelines and confirmed by a second control by a senior cardiologist.

### Statistical analysis

Continuous variables were expressed as mean ± standard deviation; categorical variables were expressed as percentage and compared with $\chi^2$ test. Correlations and trends were analysed with Pearson's test. A $p$-value $<0.05$ was considered as statistically significant.

## Results

Out of 27,841 patients enrolled, 49.2% were male, about 51.4% were older than 70 years, and 6.6% complained for palpitations. AF was diagnosed upon ECG findings in 11.7% of subjects, only 14.05% of patients with palpitations.

Forty-two per cent of 3239 patients with AF were male and 80.2% were older than 70 years. Prevalence of AF increased with age ($p < 0.001$; Figure 1). Prevalence of AF significantly increased with age, both in subjects with palpitations and in those with symptoms other than palpitations (Figure 2). Clinical presentation of AF significantly differed with age: symptoms other

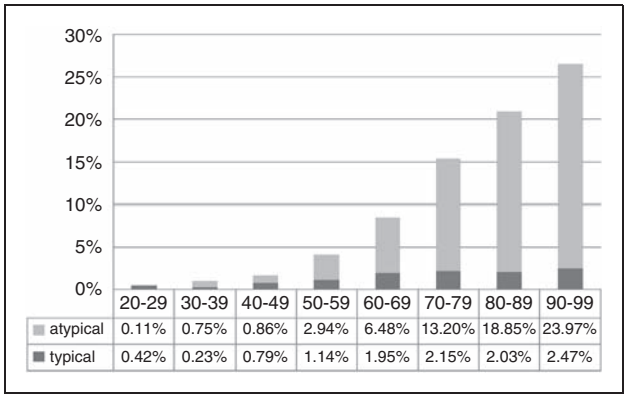



**Figure 1.** Increasing rates of prevalence of atrial fibrillation per age classes: higher rates of atrial fibrillation with atypical symptoms in older patients.

than palpitations increased from 20–52% in patients younger than 50 years to 86–91% in subjects older than 70 years ($p$ for trend <0.001; Figure 3). Palpitations therefore are not a reliable predictor of presence of AF, particularly in older patients. Rate of subjects with AF and typical symptoms significantly decreased with age (<65 years 29.58%, 65–75 years 17.06%, >75 years 10.35, $p < 0.001$).

Rate of diagnosis of AF were statistically higher in all age classes ($p < 0.001$) when tele-cardiology support was added to symptoms analysis (presence of palpitations) (Figure 4): diagnosis rate increased up to four-fold in 60–69 years old patients and more than ten-fold in older than 80 years (Figure 5).

Number of subjects to be screened in order to find a single subject with AF and atypical presentation (number needed to treat, NNT) decreased from more than 100 in subjects younger than 50 years to 34 (in 50-year-olds), 15 (60-year-olds), 8 (70-year-olds), and 5 (80-year-olds) ($p < 0.001$; Figure 6).

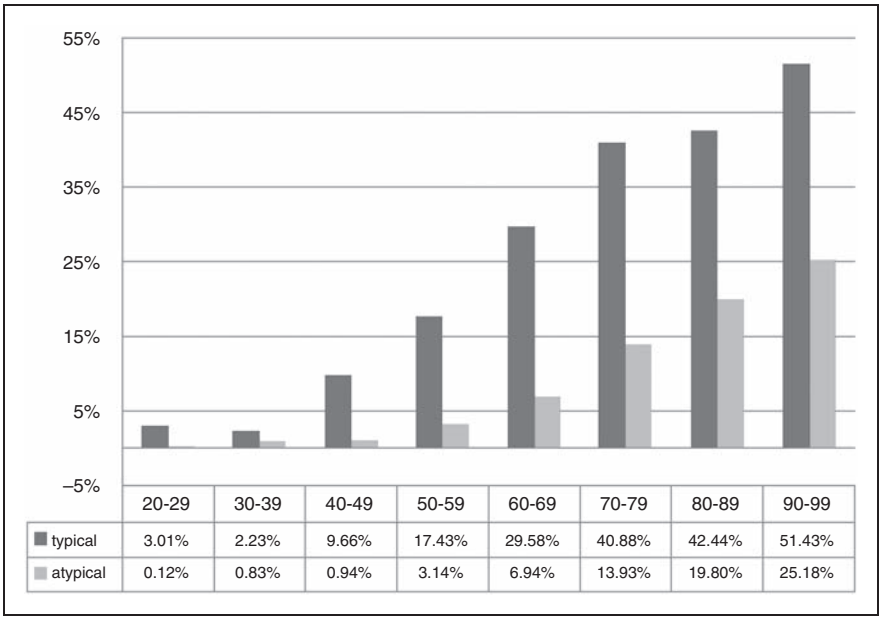
## Discussion

In the present study, we found that AF with symptoms other than palpitations is a common finding in elderly EMS patients. Tele-cardiology support improves the sensitivity of diagnosis of AF in elderly EMS patients and is useful in at-home identification of subjects with AF and atypical presentation.

Usually AF is associated with a variety of symptoms: palpitations, dyspnoea, chest discomfort, fatigue, dizziness, and syncope. However, previous studies have shown that a significant proportion of patients with AF may have no symptoms.[4] Paroxysmal AF is likely to be symptomatic and frequently presents with specific symptoms, while permanent AF is usually associated with less specific symptoms.[9] Several studies suggest that symptoms decrease with longer duration of AF.[4]

Clinical experience and experimental data generally show that patients with AF who demonstrate clinical features such as younger age, paroxysmal vs. permanent AF, higher ventricular rates, and female sex are more likely to manifest symptoms.[6] However, the data are inconsistent among the studies and significant overlap in symptom manifestation exists among different clinical subsets. It is therefore difficult to identify a clinical profile of patients who would be more or less likely to manifest symptoms.

The reported incidence of symptomatic AF depends on the monitoring frequency and the burden of AF on the cohort studied.[5] In a study by Camm et al. among asymptomatic elderly patients, the incidence of AF detected by a 24-hour ambulatory monitor was 10.5%.[10] In a prospective study with persistent AF, 68% were symptomatic whereas 32% had no symptoms;[11] in the Canada Registry of AF, 21% of patients with AF were asymptomatic.[6] In the Framingham Heart Study, 40% AF patients had asymptomatic AF.[12] When routine trans-telephonic recordings are




| | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 | 90-99 |
|---|---|---|---|---|---|---|---|---|
| typical | 3.01% | 2.23% | 9.66% | 17.43% | 29.58% | 40.88% | 42.44% | 51.43% |
| atypical | 0.12% | 0.83% | 0.94% | 3.14% | 6.94% | 13.93% | 19.80% | 25.18% |

**Figure 2.** Increasing rates of prevalence of atrial fibrillation per type of symptoms: higher rates of atrial fibrillation in older patients are detectable both in patients with typical and atypical symptoms.

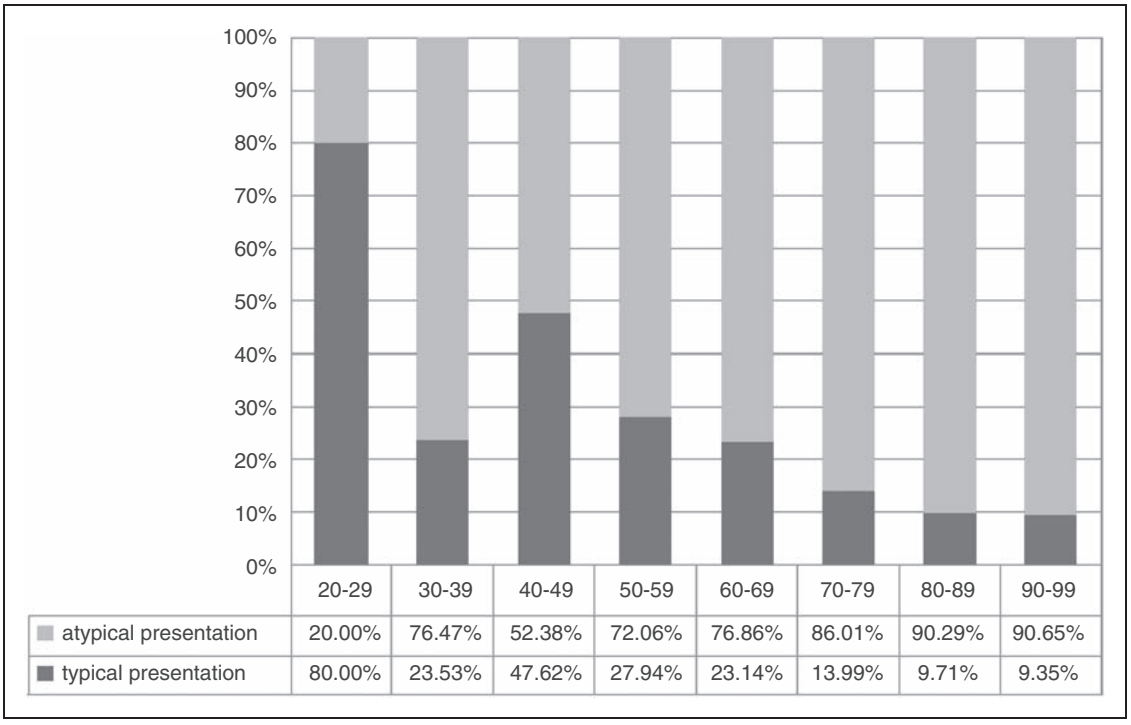



**Figure 3.** Higher rates of prevalence of atypical symptoms in older patients with atrial fibrillation.

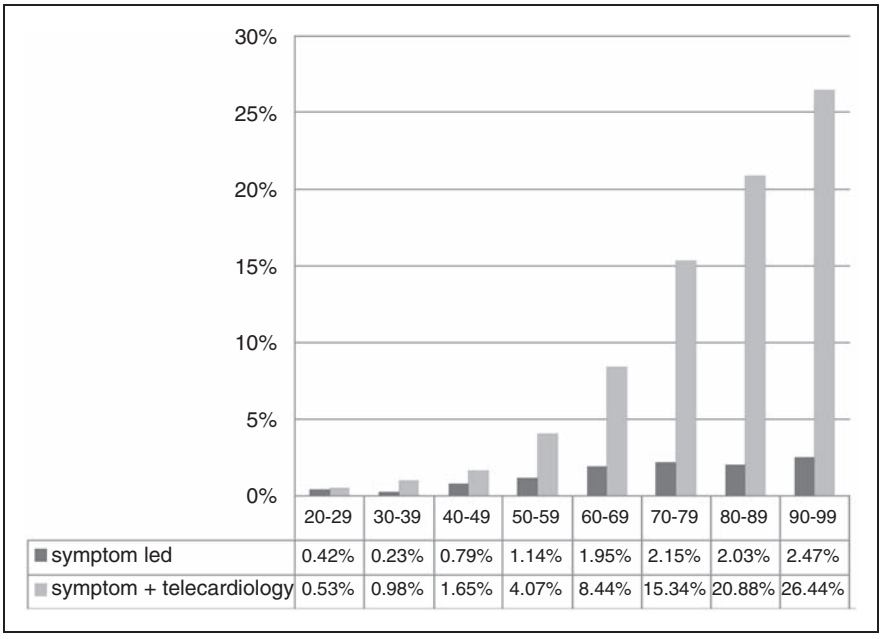



**Figure 4.** Incremental diagnostic sensitivity adding tele-cardiology at-home ECG evaluation to symptom assessment in emergency medical service patients.

performed, the incidence of asymptomatic AF recurrence may be as high as 50%.[13,14]

Recent studies have reported an even higher incidence of asymptomatic AF when pacemaker memory data are used for detection.[15] AF-related symptoms have low sensitivity and low positive predictive value in patients with permanent pacemakers.[16] The heart rate during AF directly correlates with the occurrence

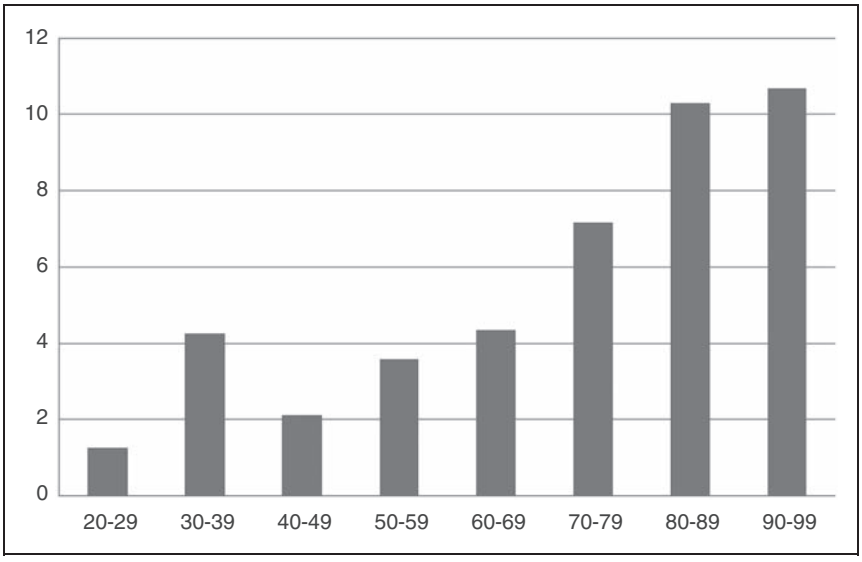



**Figure 5.** Relative incremental sensitivity available adding tele-cardiology at-home ECG evaluation to symptom assessment in emergency medical service patients.

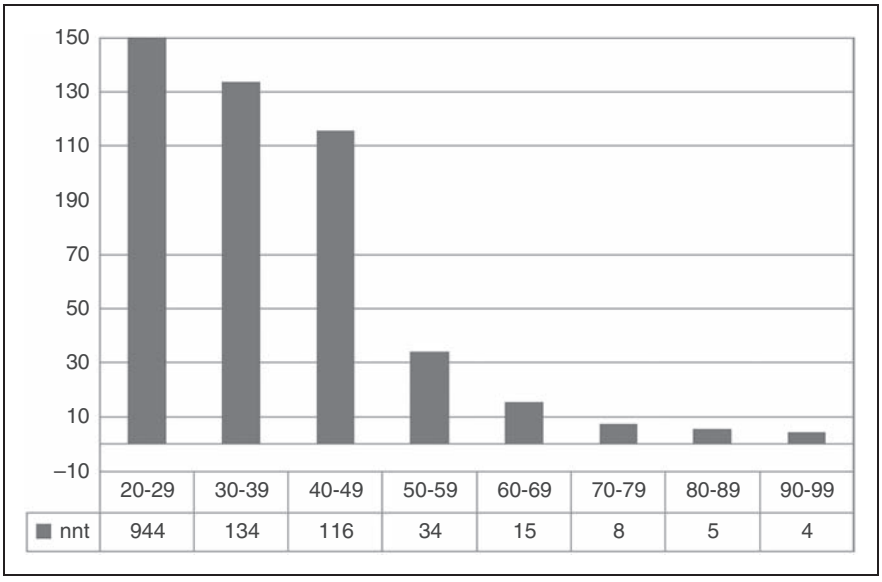



**Figure 6.** Number needed to treat: number of patients to be assessed with tele-cardiology at-home ECG evaluation in order to avoid a single missed diagnosis of atrial fibrillation (subjects with atypical presentation) ($p$ for trend $<0.001$).

of symptoms and was significantly lower during asymptomatic AF.[17] Patients' symptoms are not a reliable surrogate parameter for the prevalence of AF: when symptoms were reported, AF was diagnosed in only 37%, whereas the majority were in sinus rhythm. In a population with an implanted atrial defibrillator, a 38% incidence of asymptomatic AF was reported.[5] Furthermore, one in six patients had asymptomatic AF that persisted 48 hours or longer. These studies demonstrate a very high incidence (approximately 50% of patients) of asymptomatic bouts of AF with continuous monitoring of patients with an implantable device.

In subsets of older patients, Furberg et al. reported that 30% of patients aged 65 years or older found to be in AF on a baseline ECG were asymptomatic.[18] These studies, focused on elderly patients (a population with a significant burden of AF),[19] reported an

incidence of asymptomatic AF of between 10% and 40%. This is likely an underestimate of the true incidence, as these studies used low-intensity monitoring (in one study, a single ECG).

The mechanism by which alterations in haemodynamics are perceived by an individual with AF is not clear. Analysis of 2D echocardiograms, heart rate variability, maximum and minimum heart rate, longest pause on 24-hour Holter monitoring, and a detailed history of patients revealed valvular heart disease as the only independent predictor of symptoms.[20] In another study, there was no difference in higher heart rate, heart rate variability, or left ventricular dysfunction between patients with symptoms vs. those without.[4] Most of the asymptomatic patients presented with permanent AF: patients with permanent AF were older and more likely to be asymptomatic.

In a study enrolling 2638 AF episodes, 2305 were asymptomatic, with a sensitivity of 12.6% and a positive predictive value of 63.2% for specific AF symptoms.[21] Symptomatic AF episodes were 3.8 times more common diurnally than nocturnally. Symptomatic AF was significantly associated with a shorter AF cycle length, faster ventricular rate, shorter PR interval, faster preceding heart rate, and increased early recurrence of AF. Symptoms in AF are predicted by changes in AF episode duration, ventricular rate during AF, preceding sinus heart rate, AV nodal conduction, and AF cycle length, but not ventricular irregularity. In another study, the sensitivity and positive predictive value of symptoms to detect AF were, respectively, 19% and 21%.[16] Episode duration, rate increase at the onset of the arrhythmia, heart disease, or antiarrhythmic drug therapy showed no statistically significant differences comparing symptomatic and asymptomatic episodes. Compared with symptomatic patients, asymptomatic patients were more often men and had a lower incidence of coronary artery disease and congestive heart failure, but had more cerebrovascular events. Asymptomatic patients had a longer duration of AF, a lower maximum heart rate, and better left ventricular function.[22] They received fewer cardiac medications and fewer therapies to maintain sinus rhythm. Mortality and major events were similar after correction for baseline differences.

Symptoms cannot therefore be relied upon, even in patients who initially present with symptomatic AF. In one study, it was shown that asymptomatic AF occurred 12 times more frequently than symptomatic AF.[23] Furthermore, a history of symptomatic AF in the past in no way guarantees that recurrences will be symptomatic.

Patients with AF, however, have a five- to six-fold increase in stroke risk in comparison to patients in sinus rhythm.[24] Anticoagulation significantly reduces the risk of stroke and has been demonstrated to reduce clinical severity of strokes and mortality in patients who have strokes.[25]

The poor correlation between symptoms and AF demonstrated in these studies should caution physicians against relying on symptoms to make clinical decisions such as anticoagulation. The magnitude of asymptomatic AF reported in epidemiological studies significantly underestimates the burden of arrhythmia. Reliance on symptoms may misguide a physician's assessment of stroke risk, resulting in unsafe delay of initiation of anticoagulation and inappropriate withdrawal of anticoagulation in patients felt to be successfully rhythm controlled. In assessing stroke risk in individuals with AF, it is essential that asymptomatic AF be considered. Although symptoms may not stem directly from AF, the risk of complications is probably the same for symptomatic and asymptomatic patients. AF is found incidentally in about 25% of admissions for a stroke.[9] At 5 years, there was a trend for better survival in asymptomatic patients, and they were more likely to be free from disabling stroke or anoxic encephalopathy, major bleeding, and cardiac arrest.[22] However, mortality and major events were similar after correction for baseline differences.

According to present results, tele-cardiology at-home assessment could be proposed for early evaluation of AF in older EMS patients. Feasibility and reliability of tele-cardiology technologies applied to EMS have been already shown in previous studies that analysed the effect of at-home ECG screening in case of suspected AMI.[7,8] In these studies, at-home ECG was particularly efficient in reducing the number of wrong diagnoses in older patients with ST-elevation AMI and atypical symptoms other than chest pain.

In this study we focused on potential incremental diagnostic role of tele-cardiology at-home assessment in subjects with AF. Data were obtained from the largest and the longest experience of tele-cardiology applied to a regional EMS of Apulia, in southern Italy.[7] In the present study, tele-cardiology improved quality of diagnosis in case of AF, significantly reducing the number of wrong diagnosis in subjects with an atypical symptoms presentation and increasing the sensitivity of at-home EMS examination.

Tele-cardiology support is particularly cost-effective when applied to elderly patients, as confirmed by lower NNT found in this study in older patients. An immediate at-home ECG screening might therefore increase the diagnosis rate of AF by more than 10 fold. Furthermore, tele-cardiology support could significantly reduce delay to treatment in case of AF, particularly when anti-coagulation must be promptly started. These data seem therefore to encourage a widespread application of tele-cardiology support in EMS.

## Conclusions

AF with symptoms other than palpitations is a common finding in elderly EMS patients. Tele-cardiology support improves the sensitivity of diagnosis of AF in elderly EMS patients and is useful in at-home identification of subjects with AF and atypical presentation.

### Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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