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Prevalence of cardiac arrhythmias in pre-hospital tele-cardiology electrocardiograms of emergency medical service patients referred for syncope☆,☆☆,★,★★

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Abstract

Aim: To evaluate the rate of prevalence of significant arrhythmias in emergency medical service (EMS) subjects referred for syncope and screened with pre-hospital tele-cardiology ECG.

Methods: 2648 consecutive EMS patients referred for syncope were evaluated with tele-cardiology support. Pre-hospital ECGs were sent to a single tele-cardiology "hub", active 24/7 and serving a region of 4-million inhabitants, and promptly read by a cardiologist. Prevalence of any arrhythmias or conduction disturbances was recorded.

Results: In more than 55% of cases ECG findings were normal; in 13% ECG showed sinus tachycardia, in 9% sinus bradycardia. Prevalence of ventricular tachycardia was 0.20%, while significant AV-disturbances were present in 1.12% of cases (0.11% second-degree type 2 AV-block, 0.11% advanced AV-block, 0.19% third-degree AV-block, 0.45% junctional rhythm, 0.26% ventricular rhythm). Limited gender differences were detectable. No significant arrhythmias were found in subjects younger than 30 years. Prevalence of several arrhythmias was age related.

Conclusions: Prevalence of significant arrhythmias among EMS patients referred for syncope and evaluated with pre-hospital tele-cardiology ECG is low, and almost absent in subjects below 30 years. Tele-cardiology pre-hospital screening by a single regional "hub" may be helpful for the prompt diagnosis of arrhythmia related syncope.

Keywords: Pre-hospital ECG; Tele-Cardiology; Syncope; Arrhythmias; Emergency Medical Service; Early Diagnosis

Background

Syncope is a common and challenging presentation for the emergency physician. Recent surveys indicate that syncope accounts for approximately 1% of emergency department (ED) visits in Europe[1] and 6% of hospital admissions are related to syncope.[2]

Although most causes of syncope are benign and require no further evaluation, there is a small subset of patients for whom a syncopal episode may herald a potentially life-threatening condition.[3] Clinical risk scores[4] and clinical decision rules[5] have been developed to identify the population at highest risk for adverse events. In each of these clinical decision tools, an abnormal electrocardiogram (ECG) is one of the key clinical variables used to evaluate the patient. The presence and severity of structural heart disease are the most important predictors of mortality[6]; a prompt, possibly at-home, diagnosis of cardiac arrhythmias is therefore crucial in ruling out of a heart disease in patients calling emergency medical service (EMS).

Pre-hospital ECG assessment with tele-medicine support of EMS patients may represent a reliable tool in avoiding wrong diagnosis and reducing delay to diagnosis,[7,8] identifying significant arrhythmias needing urgent hospitalization. In this study we therefore aimed to evaluate the

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prevalence of significant arrhythmias in EMS subjects referred for syncope, screened with pre-hospital ECG with tele-medicine support, potentially reducing the needing for ED cardiologic assessment.

Methods

This pre-hospital ECG tele-cardiology program involved 27,841 patients from all over Apulia (19,362 km², 4 million inhabitants, South-Eastern Italy), who called EMS "118" since October 2004 until 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 ED delay-to-diagnosis. 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 and ECG should be preferably reported by a cardiologist.

All crews of regional "118" EMS (N = 154) were equipped with a CardioVox P12 12-lead ECG recorder (Aerotel™, Holon, Israel): the devices may record a complete 12-lead ECG which is read by a cardiologist available 24/7 after (mobile-)telephone transmission to a unique regional tele-medicine support "hub". 118 personnel (paramedics and physicians) may be shown back ECGs on smart-phones connected with tele-cardiology hub. Logistic support for tele-medicine hub was provided by Cardio-online Europe S.r.l.; about 20 cardiologists cooperated with Cardio-on-line Europe S.r.l. providing cardiologic consultancy.

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

Syncope was defined, according to current guidelines,[9] as transient loss of consciousness with rapid onset and usually accompanied by falling, followed by spontaneous, complete, and usually prompt recovery without medical intervention.[10]

ECG was read by a cardiologist and confirmed in a second blind control by a senior cardiologist. Prevalence of any arrhythmias or conduction disturbances was recorded.

Statistical analysis

Continuous variables were expressed as mean value± standard deviation and compared with t-Student test for unpaired variables and categorical variables expressed as percentage and compared with χ^2 test. A P value $< .05$ was considered as statistically significant.

Results

Out of 27,841 consecutive EMS patients enrolled and screened with pre-hospital tele-cardiology ECG for any suspected heart disease, 49.2% were male; syncope was reported in 2648 consecutive patients (mean age 66±20 years, 53% male gender). In more than 55% of patients with syncope ECG findings were normal, in 13% ECG showed sinus tachycardia, in 9% sinus bradycardia (Table 1). Prevalence of ventricular tachycardia was 0.20%, while significant AV conduction disturbances were present in 1.12% of cases (0.11% second-degree type 2 AV-block, 0.11% advanced AV-block, 0.19% third-degree AV-block, 0.45% junctional rhythm, 0.26% ventricular rhythm).

A supra-ventricular tachycardia (neither an atrial fibrillation nor an atrial flutter) was present in 0.49% of subjects, an atrial fibrillation in 9.48%, an atrial flutter in 0.38%. A sinus arrest was detectable in 0.11% of patients with syncope, a sino-atrial block in 0.08%, a pace-maker failure in 0.11%.

Prevalence of arrhythmias was often related to age (Table 1); mean age comparison between subjects presenting with arrhythmias and controls was given in Table 2.

Limited gender differences are detectable, even though without clinical relevance. No significant arrhythmias were found in subjects younger than 30 years (Fig. 1). Prevalence of grouped severe tachycardias (ventricular tachycardia, ventricular fibrillation), bradycardias (sinus arrest, AV block II 2, AV block III, advanced AV block, junctional rhythm, sino-atrial block) and any of previous arrhythmias was age related (Fig. 1). Differences in grouped arrhythmias between genders were not statistically significant (male vs female gender 0.36% vs 0.08% for tachycardias, 1.22% vs 0.80% for bradycardias, 1.58% vs 0.88% for any arrhythmias, p n.s. in all cases).

Discussion

In the present study, we found that pre-hospital tele-cardiology ECG screening may identify less than a 2% of subjects with syncope and heart rhythm anomalies needing urgent admission to a cardiology ward; other patients without significant arrhythmias were considered for additional evaluation, not needing urgent admission to a cardiology ward.

The reported prevalence of syncope in the population varies from 15% of children before the age of 18 years up to 23% in a nursing home population older than 70 years.[11] The highest frequency of syncope occurs in patients with cardiovascular comorbidity and older patients in institutional care settings.[12] Syncope prevalence figures for older people are probably an underestimate because up to 20% of these patients have amnesia for loss of consciousness.

Patients with syncope are often admitted to hospital and undergo expensive investigations, many of which do not provide a definite diagnosis.[1]

Although most causes of syncope are benign and require no further evaluation, there is a small subset of patients for whom a syncopal episode may herald a potentially life-threatening condition.[3] Clinical risk scores[4] and clinical decision rules[5] have been developed to identify the population at highest risk for adverse events. In each of these clinical decision tools, an abnormal ECG is one of the key clinical variables used to evaluate the patient. The presence and severity of structural heart disease are the most

Table 1
Prevalence of principal arrhythmias at pre-hospital tele-cardiology ECG in emergency medical service patients referred for syncope.

	PVC	repetitive PVC	VT	VF	PSVC	repetitive PSVC	SVT	Atrial flutter	AF	HR-AF	AV-block I	AV-block II–I	AV-block II–II	advanced AV-block	AV-block III	junctional rhythm	idioventr. rhythm	LR-AF	Age Class
Row %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0–20
Total %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.66%
Row %	1.94%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20–30
Total %	0.08%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.89%
Row %	2.45%	-	-	-	0.61%	-	0.61%	-	1.23%	0.61%	-	-	-	-	-	0.61%	-	-	30–40
Total %	0.15%	-	-	-	0.04%	-	0.04%	-	0.08%	0.04%	-	-	-	-	-	0.04%	-	-	6.16%
Row %	-	-	-	-	0.44%	0.44%	0.44%	-	-	0.44%	-	-	0.44%	-	-	-	-	-	40–50
Total %	-	-	-	-	0.04%	0.04%	0.04%	-	-	0.04%	-	-	0.04%	-	-	-	-	-	8.65%
Row %	1.82%	0.36%	0.73%	-	1.09%	-	1.09%	-	1.82%	1.09%	1.45%	-	0.36%	-	-	-	-	-	50–60
Total %	0.19%	0.04%	0.08%	-	0.11%	-	0.11%	-	0.19%	0.11%	0.15%	-	0.04%	-	-	-	-	-	10.39%
Row %	2.17%	0.54%	-	0.27%	1.36%	-	-	0.27%	4.62%	2.99%	1.09%	0.27%	-	0.27%	-	-	0.54%	0.27%	60–70
Total %	0.30%	0.08%	-	0.04%	0.19%	-	-	0.04%	0.64%	0.42%	0.15%	0.04%	-	0.04%	-	-	0.08%	0.04%	13.90%
Row %	3.12%	0.43%	0.28%	-	3.12%	0.28%	0.57%	-	8.94%	3.12%	2.41%	-	-	0.28%	0.43%	0.43%	0.57%	0.43%	70–80
Total %	0.83%	0.11%	0.08%	-	0.83%	0.08%	0.15%	-	2.38%	0.83%	0.64%	-	-	0.08%	0.11%	0.11%	0.15%	0.11%	26.62%
Row %	3.87%	0.35%	-	-	5.11%	0.70%	0.53%	1.06%	12.68%	3.52%	3.52%	0.35%	0.18%	-	0.35%	0.88%	0.18%	1.58%	80–90
Total %	0.83%	0.08%	-	-	1.10%	0.15%	0.11%	0.23%	2.72%	0.76%	0.76%	0.08%	0.04%	-	0.08%	0.19%	0.04%	0.34%	21.45%
Row %	6.25%	0.78%	0.78%	-	6.25%	3.13%	0.78%	2.34%	9.38%	4.69%	8.59%	-	-	-	-	2.34%	-	1.56%	90–100
Total %	0.30%	0.04%	0.04%	-	0.30%	0.15%	0.04%	0.11%	0.45%	0.23%	0.42%	-	-	-	-	0.11%	-	0.08%	4.83%
Row %	-	-	-	-	-	-	-	-	16.67%	8.33%	-	-	-	-	-	-	-	-	>100
Total %	-	-	-	-	-	-	-	-	0.08%	0.04%	-	-	-	-	-	-	-	-	0.45%
Total %	2.68%	0.34%	0.19%	0.04%	2.61%	0.42%	0.49%	0.38%	6.53%	2.45%	2.11%	0.11%	0.11%	0.11%	0.19%	0.45%	0.26%	0.57%	100.00%

Legend: PVC—premature ventricular contractions, PSVC—premature supra-ventricular contractions, AF—atrial fibrillation, AV—atrio-ventricular, HR—high rate, LR—low rate, VT ventricular tachycardia, VF—ventricular fibrillation, SVT—supra-ventricular tachycardia.

Table 2
Mean age comparison between subjects with arrhythmia and controls.

arrhythmia	+	s.d.	-	s.d.	p
PVC	74.3	16.5	65.7	20.3	<0.001
PSVC	79.3	10.4	65.6	20.3	<0.001
repetitive PVC	74.4	11.5	65.9	20.3	n.s.
repetitive PSVC	83.2	13.3	65.9	20.3	<0.01
SVT	69.5	16.8	65.9	20.3	n.s.
AF	78.8	11.2	65.0	20.4	<0.001
High rate AF	76.9	11.2	65.7	20.4	<0.001
Low rate AF	82.7	7.4	65.8	20.3	<0.01
Atrial Flutter	84.3	9.1	65.9	20.3	<0.01
Idioventricular rhythm	74.3	4.3	65.9	20.3	n.s.
VT	73.4	14.9	65.9	20.3	n.s.
sinus tachycardia	56.2	22.9	67.4	19.5	<0.001
sinus bradycardia	68.0	16.5	65.7	20.6	n.s.
I degree AV-block	80.5	11.0	65.6	20.3	<0.001
III degree AV-block	78.6	3.9	65.9	20.3	n.s.
junctional rhythm	81.3	16.1	65.9	20.3	<0.01
any severe arrhythmia	75.6	14.2	65.8	20.3	<0.01
severe tachycardia	72.5	13.5	65.9	20.3	n.s.
severe bradycardia	76.3	14.5	65.8	20.3	<0.01

Abbreviations: PVC—premature ventricular contraction; PSVC—premature supra-ventricular contraction; SVT—supra-ventricular tachycardia; AF—atrial fibrillation; VT—ventricular tachycardia; AV—atrio-ventricular.
Severe tachycardia: ventricular tachycardia, ventricular fibrillation.
Severe bradycardia: sinus arrest, AV block II 2, AV block III, advanced AV block, junctional rhythm, sino-atrial block.
Severe arrhythmia: severe tachycardia, severe bradycardia.

important predictors of mortality[6]; a prompt, possibly at-home, diagnosis of cardiac arrhythmias is therefore crucial in ruling out of a heart disease in patients calling EMS. An ECG should thus be ordered for all patients with syncope.[13] Although the cost-effectiveness of ECG has been questioned,[14] it is risk free and relatively inexpensive.[10]

Abnormal ECG findings are common in patients with syncope.[11] However, a negative ECG examination identifies patients at very low risk for future adverse events. In a prospective, short-term study of patients presenting after a syncopal episode, follow-up interviews one month later revealed no repeat ED visits, hospitalizations, or deaths.[15]

The presence of a structural heart disease is associated to a poor prognosis. The 1-year mortality of patients with cardiac syncope is consistently higher than patients with non-cardiac cause or unexplained syncope.[11] Abnormal ECG findings occur in about 90% of patients with cardiac-induced syncope but in only 6% of patients with neurally mediated syncope.[11] A normal ECG in a patient with syncope therefore identifies subjects with a very low probability of structural heart disease and with a consequent low risk of adverse events. In one study, none of the patients with syncope who had a negative cardiac history and a normal ECG had an abnormal echocardiogram.[16]

For patients with isolated or rare syncopal episodes, who have no evidence of structural heart disease and a normal baseline ECG, the probability is high that the event was of a neurally mediated origin. These patients have a low mortality risk (although recurrences and physical injury are possible), and generally their evaluation can be completed entirely on an out-patient basis.[17]

As found in this study, significant arrhythmias are quite absent in subject younger than 30 years. As previously

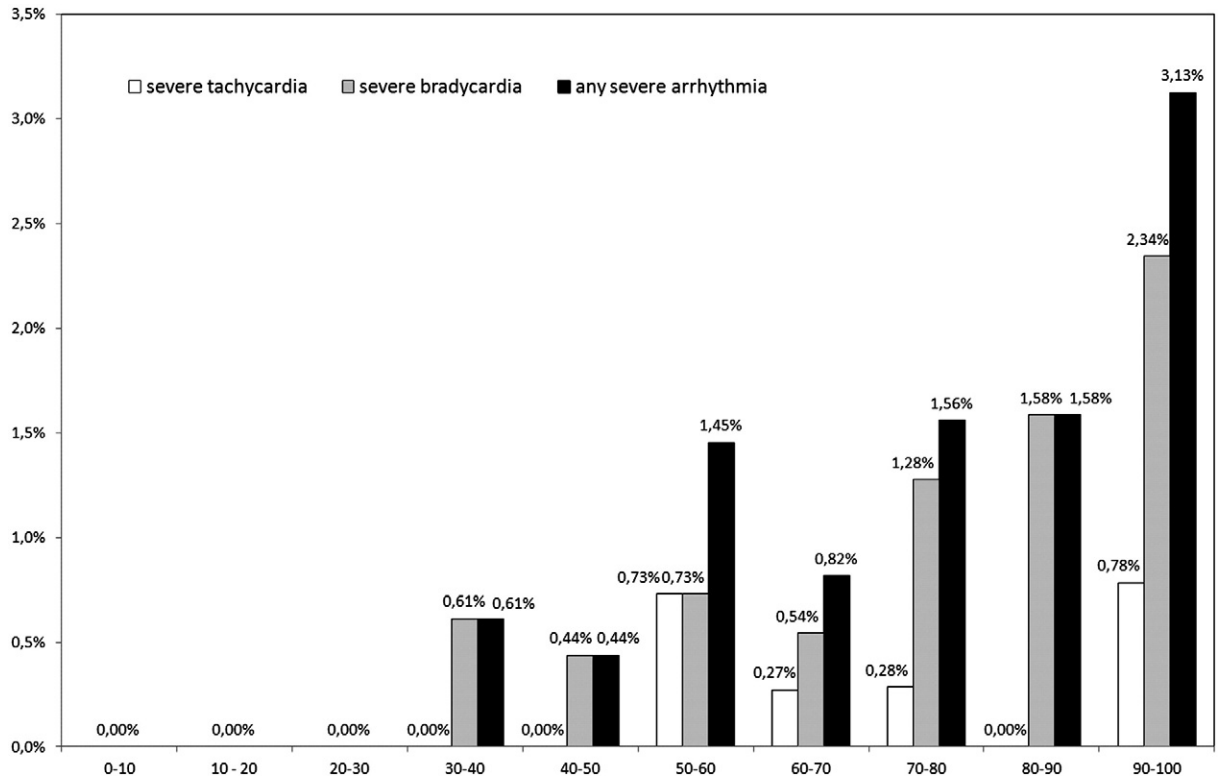

Fig. 1. Prevalence of grouped severe tachycardias, bradycardias and any of previous arrhythmias by age-class. Legend: Tachycardia (ventricular tachycardia, ventricular fibrillation): Bradycardia (sinus arrest, AV block II 2, AV block III, advanced AV block, junctional rhythm, sino-atrial block); arrhythmias (any of tachycardia or bradycardia).

reported, probably a neurally mediated syncope is more common in younger patients than in older. In a prior study relationship between clinical presentation of syncope and age of the patients, a neurally mediated cause was established in 54% of older (>65 years) and in 68% of younger patients.[18] Compared with younger patients, the medical history has a limited value in the diagnosis of the cause of syncope in older patients. Syncope is relatively more common among older patients: more than 75% of persons older than 70 years will experience syncope at least once.[6] However, evaluating elderly patients after a witnessed syncopal event might be a difficult task. Studies suggest that history, physical examination, and ECG have as much diagnostic yield as all other tests combined.[10]

In a large study on 39,943 ED visits for syncope, risk of cardiac events sharply decreased following the 7 days after syncope.[19] A 7-day cardiac outcome occurred in 3% of cases. Positive predictors of 7-day cardiac outcomes included age>or =60 years, male gender, congestive heart failure, ischemic heart disease, cardiac arrhythmia, and valvular heart disease. Negative predictors included dementia, pacemaker, coronary revascularization, and cerebrovascular disease. There was an age-dependent relation between 7-day cardiac outcomes and arrhythmia and valvular disease, with younger patients (<60 years of age) having greater risk of an event compared to their same-age counterparts. Authors conclude that ED decision-making should focus on risk of cardiac event in the first 7 days after syncope and special attention should be given to younger patients with cardiac co-morbidities. In another study, syncope remained unexplained more frequently in the elderly (54% vs 37% in middle-aged and 43% in older adults) and syncope recurrence was higher in the middle-aged and elderly groups.[20] Overall mortality for the 3 age groups was similar to that recorded in the general population after adjustment for age and co-morbidities. Etiology of syncope was not associated with age- and comorbidity-adjusted all-cause mortality. Cardiovascular mortality was significantly higher in patients with cardiogenic syncope (adjusted hazard ratio, 2.44). In a series of 146 patients admitted for syncope, 2/3 were aged 65 years and older.[21] A specific etiology could be established in 62%, and 3/4 of these were cardiovascular in origin. In-hospital mortality was 2.1% and mortality at the end of the approximately 2-year follow-up period was 18.1%. Mortality was higher for persons over age 65 than for younger persons (23.9% vs 2.3%), and for persons with cardiovascular syncope than for persons with other kinds of syncope (28.3% vs 8.9%).

According to present results, pre-hospital ECG assessment by tele-medicine support could be proposed for early evaluation of syncope in EMS patients. Tele-medicine support may allow almost every patient with syncope and suspected cardiovascular emergency calling EMS 118 to be promptly evaluated by a cardiologist wherever the patient is within the region. Feasibility and reliability of tele-cardiology technologies applied to EMS have been already shown in previous studies that analyzed the effect of pre-hospital ECG screening in case of suspected acute myocardial infarction.[7,8] In these studies, pre-hospital ECG was particularly efficient in reducing the number of wrong diagnoses in older patients with ST-elevation acute myocardial infarction and atypical symptoms other than chest pain.

The very low incidence of significant arrhythmias and their near absence among younger patients might support a strategy addressing most of these patients with a normal pre-hospital ECG, without signs of both arrhythmias and structural heart disease, towards more non-cardiologic oriented evaluations.

On the other hand, a prompt pre-hospital diagnosis by tele-medicine support of significant arrhythmias needing urgent admission to a cardiology ward may possibly avoid wrong diagnoses and reduce delay to treatment for such patients with syncope and arrhythmias at 12-lead ECG.[22]

Conclusions

Prevalence of significant arrhythmias among EMS patients referred for syncope and evaluated with pre-hospital tele-medicine ECG is low, and almost absent in subjects below 30 years. Tele-medicine pre-hospital screening by a single regional “hub” may be helpful for the prompt diagnosis of significant arrhythmias needing immediate admission to cardiology ward without any ED “delaying detours”.

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