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Paediatric extrasystole in numbers – single-centre arrhythmic experience

Pobudzenia dodatkowe serca u dzieci w liczbach – doświadczenia własne

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Abstract

Aim: Supraventricular and ventricular extrasystole are the most common form of arrhythmia in paediatric cardiology, but still they may be confusing for paediatricians and family doctors. The aim of the study was to assess the scale of the problem based on the data from a single-centre department of paediatric cardiology. **Materials and methods:** This single-centre retrospective study analysed medical documentation of a total of 90 children hospitalised in the Department of Paediatric Cardiology due to suspected or diagnosed extrasystole from January 1st to December 31st 2019. **Results:** The study group of 90 children aged between 3 days and 17.8 years (57% male, mean age 11.1 ± 5.7 years) accounted for 4% of all hospitalisations. This was a new diagnosis in 35 (39%) patients, and 17 (19%) cases were referred as an emergency. Clinical symptoms were observed in 26 (29%) children. Extrasystole were registered in 74 patients (82%) using 24-hour Holter electrocardiographic monitoring. Premature ventricular extrasystole was the most common form of arrhythmia. Complex arrhythmias were registered in 18 (24%) patients. In 3 patients, arrhythmic burden exceeded 20%. Echocardiography showed no abnormalities in 67 (74%) children. A total of 11 children had a history of surgery due to congenital heart defects. In none of patients arrhythmia increased on exertion during treadmill test. A life-threatening cause of arrhythmia was detected in only 2 cases. A total of 18 patients required antiarrhythmic therapy. **Conclusions:** Supraventricular and ventricular extrasystoles are a common, but rarely life-threatening condition in children. It is important to establish the diagnosis and identify high-risk patients requiring treatment or close follow-up.

Keywords: extrasystole, supraventricular arrhythmia, ventricular arrhythmia, children

Streszczenie

Cel pracy: Nadkomorowe i komorowe pobudzenia przedwczesne, jako najczęściej spotykana forma arytmii u dzieci, są powszechnym źródłem wątpliwości diagnostycznych i terapeutycznych w praktyce pediatrów i lekarzy rodzinnych. Celem badania było określenie skali problemu na podstawie danych zebranych w pojedynczym referencyjnym ośrodku kardiologii dziecięcej w ciągu 12 miesięcy. **Materiał i metody:** Jednoośrodkowym retrospektywnym badaniem objęto dokumentację 90 pacjentów hospitalizowanych na oddziale kardiologii dziecięcej z powodu podejrzenia lub rozpoznania dodatkowych skurczów serca w okresie od 01.01 do 31.12.2019 roku. **Wyniki:** Badana grupa 90 dzieci w wieku od 3 dni do 17,8 roku (57% chłopców, średnia wieku 11,1 ± 5,7 roku) stanowiła 4% wszystkich hospitalizowanych chorych. U 35 (39%) pacjentów arytmia była nowo rozpoznana, 17 (19%) przyjęć odbyło się w trybie pilnym. U 26 (29%) dzieci arytmii towarzyszyły objawy kliniczne. Podczas 24-godzinnego monitorowania elektrokardiograficznego metodą Holtera pobudzenia dodatkowe zarejestrowano u 74 (82%) pacjentów, u 3 arytmia stanowiła ponad 20% pobudzeń w ciągu doby. Najliczniej reprezentowaną postacią arytmii były przedwczesne pobudzenia komorowe. U 18 (24%) pacjentów zarejestrowano złożone formy arytmii. U 67 (74%) dzieci badanie ECHO nie wykazało nieprawidłowości. 11 pacjentów operowano z powodu wrodzonej wady serca. U żadnego pacjenta w trakcie próby wysiłkowej nie obserwowano nasilenia arytmii. Tylko u 2 dzieci rozpoznano zagrażające życiu choroby arytmiczne. Farmakologicznego leczenia antyarytmicznego wymagało 18 pacjentów. **Wnioski:** Nadkomorowe i komorowe pobudzenia przedwczesne są częstą, ale rzadko groźną formą arytmii u dzieci. Ustalenie rozpoznania i trafne wyselekcjonowanie pacjentów wysokiego ryzyka stanowią podstawę opieki nad dziećmi z zaburzeniami rytmu serca.

Słowa kluczowe: pobudzenia dodatkowe, arytmia nadkomorowa, arytmia komorowa, dzieci

INTRODUCTION

Many family doctors and paediatricians encounter children with arrhythmia in their everyday practice. Arrhythmia is usually identified during infection, routine well-child check-up or qualification for sports. General practitioners easily detect extrasystole during careful heart auscultation, and they can identify whether the extra beats are of supraventricular or ventricular origin (single supraventricular extrasystole – SVES or ventricular extrasystole – VES) based on electrocardiography (ECG). However, the decision on how to proceed with an arrhythmic child, either with previously established or new diagnosis, or even a mere suspicion of the problem may pose a challenge for a paediatrician or a family doctor. Understanding of arrhythmic pathology and its main characteristics in paediatric population helps choose more effective diagnostic and therapeutic approaches.

The aims of the study were to characterise a paediatric population with extrasystole and assess the scale of the problem based on the data from a single-centre department of paediatric cardiology. The goal of this analysis was to help paediatricians and family doctors understand the problem and plan adequate management.

MATERIALS AND METHODS

We conducted a retrospective cross-sectional single-centre study covering the time between January 1st and December 31st 2019. All consecutive patients suspected or already diagnosed with arrhythmia in the form of SVES or/and VES were included in the study. Patients were excluded from the analysis if they were admitted for scheduled electrophysiological study due to previously diagnosed supraventricular tachycardia (SVT) and/or preexcitation. All patients underwent routine diagnostic evaluation: ECG, echocardiogram (ECHO), and 24-hour Holter ECG monitoring. In justified cases, laboratory tests, treadmill test and/or cardiac magnetic resonance (CMR) were performed.

Feature	Study group $n = 90$
Mean age, *SD* [years]	11.1 ± 5.7
Male sex	51 (57%)
Family history of SCD	0
Check-up admission	55 (61%)
Mean age at diagnosis	7.1 ± 4.9
History of cardiac surgery	11
Symptomatic patients	14
Pharmacotherapy	10
SVA	21
VA	29
Both	5
First time admission	35 (39%)
Emergency	17
Symptomatic patients	12
SCD – sudden cardiac death; **SVA** – supraventricular arrhythmia; **VA** – ventricular arrhythmia.	

Tab. 1. Patient baseline characteristics

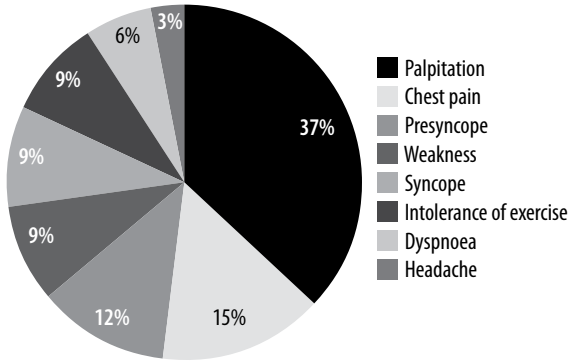

Fig. 1. Symptoms reported by patients

RESULTS

A total of 90 children (males $n = 51$, 57%) aged 3 days – 17.8 years (mean age 11.1 ± 5.7) were admitted due to suspected or diagnosed premature beats, which accounted for 4% of all hospitalisations in the Department of Paediatric Cardiology in 2019. The baseline patients' characteristics are presented in Tab. 1.

Out of 90 patients, 55 (61%) have already been diagnosed with arrhythmia, while 35 (39%) were admitted for the first time, including 17 (19%) patients referred as an emergency. Among the patients admitted for check-up, ventricular arrhythmia was previously identified in 29, supraventricular arrhythmia in 21, and both ventricular and supraventricular arrhythmia in 5 children.

Extracardiac causes of arrhythmia, like fever and infection, medications, toxins, endocrine pathologies and electrolyte imbalance, were not found in any of the children.

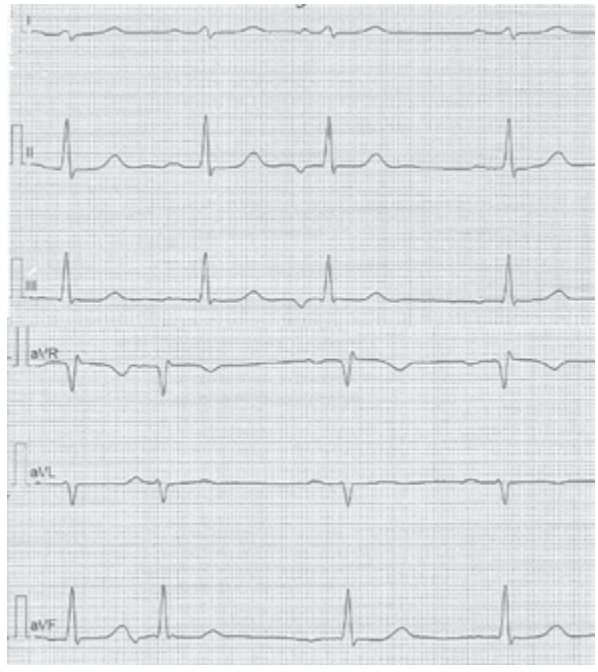

Fig. 2. ECG of a 14-year-old patient with supraventricular extrasystole

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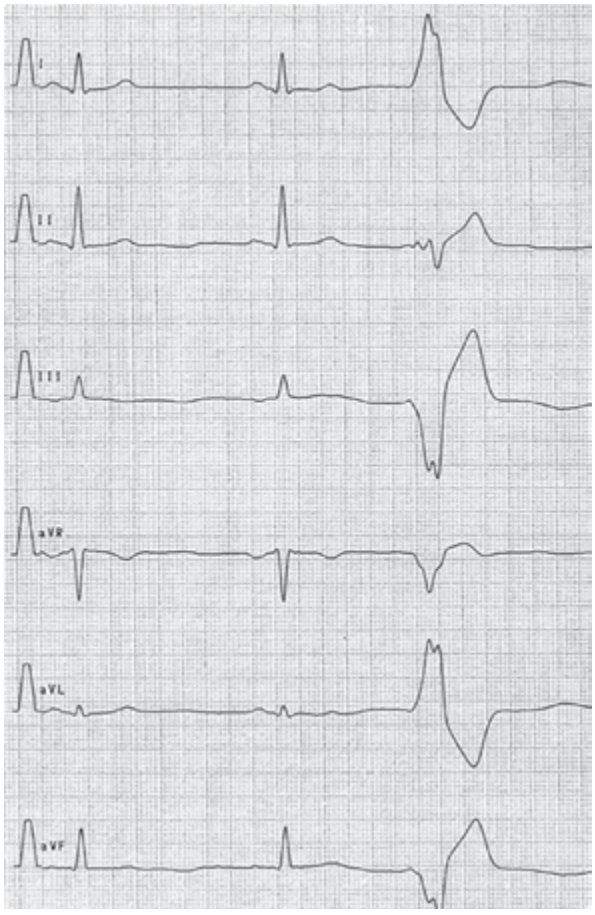

Fig. 3. ECG of a 12-year-old patient with additional ventricular extrasystole

In the total analysed group, 64 (71%) patients were asymptomatic, while 26 (29%) children reported clinical symptoms, sometimes of varying nature or multiple types. From the group of 35 children admitted for the first time, clinical symptoms were observed in 12 (34%) patients. The most common clinical manifestations included palpitations (n = 12), chest pain (n = 5), presyncope (n = 4), syncope (n = 3), weakness (n = 3), intolerance of exertion (n = 3), dyspnoea (n = 2), and headache (n = 1); 6 among the symptomatic children reported compilation of the above mentioned symptoms (Fig. 1).

In the subgroup of 26 symptomatic patients, ventricular arrhythmia was found in 9, supraventricular arrhythmia in 9, both types in 1, no arrhythmia in 5, and marked irregularity of the sinus rhythm in 2 patients.

A 24-hour Holter ECG monitoring was performed in all patients. Extrasystoles were confirmed in 74 (82%) children: ventricular in 41 (45%) patients, supraventricular in 27 (30%) patients, and both types (SVES + VES) of arrhythmia in 6 (7%) patients. Examples of arrhythmias are presented in Figs. 2 and 3.

No extrasystoles were found in 16 children: 11 from the group of patients with suspected arrhythmias and 5 with previously diagnosed SVES/VES. Marked, yet physiological,

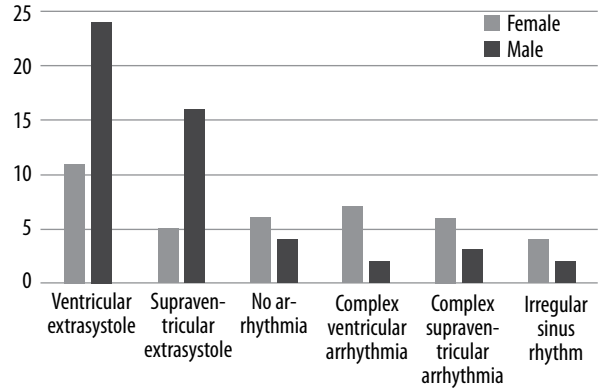

Fig. 4. Classification of patients by the type of arrhythmia and sex

irregularity of sinus rhythm was detected in 6 patients. Intermittent preexcitation was recorded in 2 symptomatic children with no registered extrasystole. Notably, an analysis of symptom diary during 24-hour Holter ECG monitoring showed no correlation between arrhythmia and reported symptoms in any of the symptomatic children.

Among 74 children with confirmed arrhythmia, only single premature beats were found in 56 (76%) patients. Complex arrhythmias (9 ventricular and 9 supraventricular), defined as pairs or tachycardias, were registered in 18 (24%) patients.

Only 3 children from the study population had an over 20% arrhythmic burden during 24-hour Holter ECG monitoring; all of them had ventricular arrhythmia.

Detailed characteristics of arrhythmias registered in the study population is shown in Fig. 4.

Out of all 90 analysed patients, 67 (74%) had no echocardiographic abnormalities. A total of 11 children underwent cardiac surgery for congenital heart defects in infancy, with good treatment outcomes in 9 patients and significant pulmonary regurgitation and enlargement of the right ventricle in 2 patients after tetralogy of Fallot repair. As for the remaining 12 children: 7 had mitral valve prolapse, 3 had bicuspid aortic valve, atrial septal defect was detected in 1 child, and 1 patient had mildly reduced left ventricular ejection fraction.

Among the arrhythmic children with a history of surgical treatment for congenital heart disease (n = 11), 8 had ventricular arrhythmias (5 single beats, 3 complex forms), 3 children had supraventricular extrasystole, including 1 with SVT detected during 24-hour Holter ECG monitoring.

Treadmill test was performed in 49 of patients over 7 years of age with confirmed extrasystole (excluding patients with arrhythmogenic cardiomyopathy considered as contraindication), and the arrhythmia resolved or was not affected by exertion in all cases.

A total of 11 patients were qualified for CMR, including 9 children with severe ventricular arrhythmia (>20% arrhythmic burden during 24 hours or complex forms), among them 5 were athletes. Abnormalities were found in only 3 patients. In 2 of them, a 16- and a 17-year-old girls,

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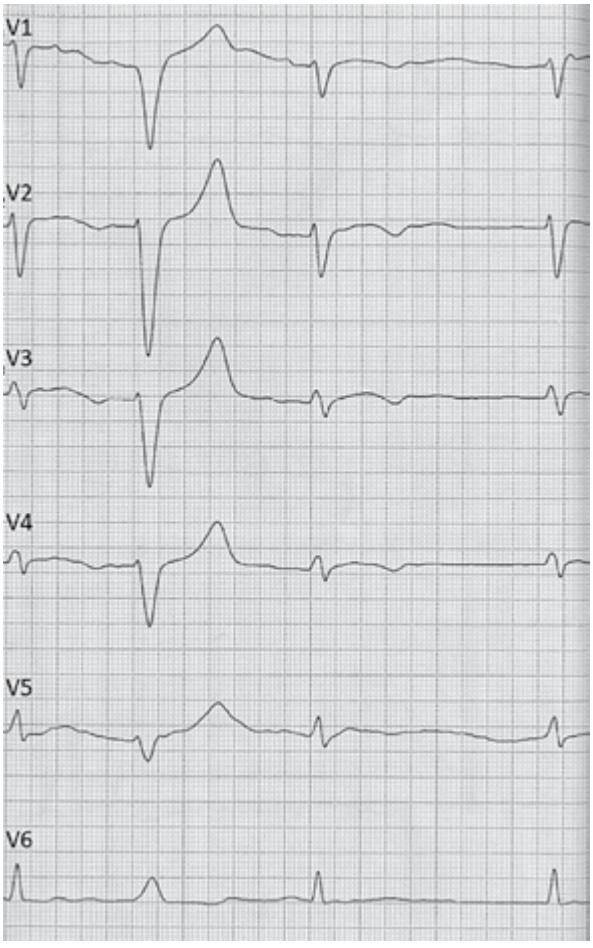

Fig. 5. ECG in a 17-year-old patient with diagnosed ARVC, visible negative T waves in leads V1–V4, ventricular extrasystole with LBBB (left bundle branch block) morphology

CMR showed right ventricular wall dyskinesia with elevated right ventricular end-diastolic volume index, which met the minor criteria for arrhythmogenic right ventricular cardiomyopathy (ARVC) and, combined with clinical criteria, such as complex ventricular arrhythmia (left bundle branch block morphology) and characteristic repolarisation abnormalities in resting ECG (negative T waves in precordial leads V1–V3), allowed to establish the diagnosis of ARVC (Fig. 5).

In another case, late gadolinium enhancement (interpreted as post inflammatory fibrosis) was registered in a symptomatic child with single ventricular arrhythmia and a history of myocarditis.

In 3 patients with suspected active myocarditis (based on reported chest pain and new diagnosis of arrhythmia), plasma troponin levels were either negative or only slightly elevated and further diagnostic work-up (including CMR in 1 patient) ruled out myocarditis as the cause of arrhythmia.

Of all the patients with extrasystole, 56 (76%) did not require antiarrhythmic treatment. Antiarrhythmic therapy was needed in 18 patients (12 children with VES and 6 children with SVES); it was initiated in 9 and continued in 9 children, requiring a change of the drug in 2 cases. The therapy was discontinued in 1 child due to intolerance. Beta-blockers were used as the first-line treatment and, in the case of ineffectiveness, class IC antiarrhythmics were included. None of the children with SVESs or VESs required ablation (Tab. 2).

Pharmacotherapy:	18 (24%)
Metoprolol	9
Propranolol	6
Propafenone	2
Sotalol	1

Tab. 2. Pharmacotherapy

DISCUSSION

Although supraventricular and ventricular extrasystole are the most common forms of arrhythmia seen in children, they are rarely the cause of hospitalisation in paediatric cardiology departments, which is consistent with the data obtained in our study. In our cohort, the largest group was comprised of patients with ventricular extrasystole, which corresponds to a study in a large paediatric population by Niwa et al. (n = 152,322)[1]. This could be due to the fact that ventricular dysrhythmias arouse great anxiety among paediatricians and family doctors, which is why such patients are more often referred to hospital. If a new diagnosis of VES is established, it calls for search of potential myocardial pathologies[2].

Supraventricular extrasystoles are mild in most cases and do not require extended diagnosis. Occasionally, complex forms of arrhythmia, including SVT, may be registered during diagnostic work-up, which may require pharmacological treatment or ablation.

Most children with extrasystole are asymptomatic, have no comorbidities, no structural heart diseases in echocardiography, and the arrhythmia is not life threatening, does not require treatment and has a tendency to resolve spontaneously with age, as proved to be the case in 5 of our patients with VES/ SVES, who were admitted for a routine check-up. Children with benign arrhythmia can play sports without restrictions[3,4].

Reversible extracardiac causes of arrhythmias, such as fever and infection, medications, toxins (including drugs), endocrine pathologies (hyperthyroidism) and electrolyte imbalance, should always be considered.

Palpitations dominate among the symptoms reported by patients. However, the exact relationship between the symptoms and arrhythmia is rarely established[5].

As illustrated by an example of 6 patients from our cohort, irregular heart rate on physical examination may be a result of physiological sinus rhythm rate variability dependent on breathing and particularly marked in children. It may be confused with arrhythmia, although auscultation while holding breath in cooperative children and, above all,

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Red flags in arrhythmia:
- SCD in the family
- symptoms on exertion
- heart failure symptoms
- bidirectional or polymorphic VES
- new finding during/after infection
- elevated troponin levels

Tab. 3. Red flags in arrhythmias

ECG are perfectly reliable methods for establishing accurate diagnosis.

Heart defects may predispose to arrhythmias even after cardiac surgery[6]. It is worth noting that every child after surgical correction of heart defect, even children with optimal treatment outcomes, may present with arrhythmia at any time after surgery. The source of arrhythmias in such cases is not only the altered size of heart chambers, but also fibrous scarring of cardiac muscle.

In our cohort, only 2 symptomatic (presyncope and syncope) patients with complex bidirectional ventricular arrhythmia turned out to be a high risk cases after the diagnosis of ARVC was established. The presence of complex arrhythmias, especially polymorphic forms, can be a sign of serious diseases, although additional diagnostic criteria are usually needed. It is worth to remember about potentially dangerous causes of arrhythmia in children. Particular diagnostic vigilance is needed in patients with VES of the left bundle branch morphology, as it can be a sign of ARVC, as shown in 2 patients in the study group[7,8]. However, single extra beats are rarely related to underlying serious heart disease such as myocarditis, channelopathy, heart muscle disease, or tumour. CMR should be considered in children with severe idiopathic arrhythmia, especially athletes. CMR imaging allows to identify the arrhythmogenic substrate in the heart muscle, showing myocardial structural abnormalities like fibrosis, oedema, replacement of muscle with fat tissue, more accurately than ECHO[9].

Active myocarditis may also be arrhythmogenic and its suspicion is one of the most common reasons for hospitalisation among patients with newly detected arrhythmia. The presence of irregular cardiac activity in a patient without prior diagnosis, found during or after infection, especially in the presence of chest pain or weakness, should prompt the doctor to measure plasma troponin. If markers of myocardial injury are positive, patients should be referred to a hospital.

The treatment depends on the type and severity of arrhythmia, coexistence of myocardial pathology, as well as patient preferences[2,10]. The majority of benign cases of extrasystole can be followed-up in outpatient clinics. More urgent cardiological assessment is advised for children with newly diagnosed symptomatic arrhythmias (especially when the symptoms appear on exertion), with known or suspected coexisting novel or aggravating cardiovascular pathologies or family history of dangerous arrhythmia or sudden cardiac death (SCD)[11,12].

Examples of "red flags in arrhythmias" are shown in Tab. 3. These patients should be referred to hospital for further diagnosis.

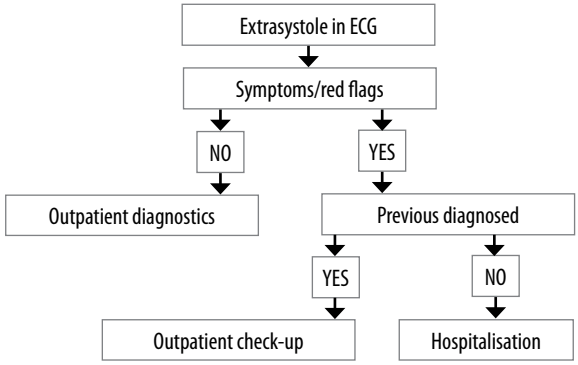

Fig. 6. A flowchart for the management of patients with arrhythmia

Despite the alarming symptoms suggesting arrhythmia, the diagnostic work-up fails to find any abnormalities during cardiac diagnosis in some children. This may be due to the limitations of the tests performed. Therefore, it is extremely important that paediatricians and family doctors have the opportunity to perform ECG in patients during symptom duration.

Based on our experience, we proposed a management scheme for patients with arrhythmia (Fig. 6).

CONCLUSIONS

Supraventricular and ventricular extrasystole in children are a common, but rarely life-threatening condition. It is important to establish the diagnosis and identify high-risk patients requiring treatment or close follow-up.

Conflict of interest

The authors do not declare any financial or personal links with other persons or organisations that might adversely affect the content of the publication or claim any right to the publication.

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