Scientific Research Publishing

Open Journal of Emergency Medicine, 2024, 12, 85-94
https://www.scirp.org/journal/ojem
ISSN Online: 2332-1814
ISSN Print: 2332-1806

Cardioembolic Stroke as a Sequela of General Ventricular Hypokinesia Secondary to Acute Myocarditis in a 16-Year-Old Male

Abdul Khattan Rehman[1], Renaldo Pavrey[2], Nazir Juvale[3], Murtaza Bagwala[1]

[1]Department of Emergency Medicine, Saifee Hospital, Mumbai, India
[2]Department of Emergency Medicine, Nanavati Max Super Specialty Hospital, Mumbai, India
[3]Department of Cardiology, Saifee Hospital, Mumbai, India
Email: renaldo.pavrey@gmail.com

How to cite this paper: Rehman, A.K., Pavrey, R., Juvale, N. and Bagwala, M. (2024) Cardioembolic Stroke as a Sequela of General Ventricular Hypokinesia Secondary to Acute Myocarditis in a 16-Year-Old Male. *Open Journal of Emergency Medicine*, **12**, 85-94.
https://doi.org/10.4236/ojem.2024.123011

Received: July 3, 2024
Accepted: September 16, 2024
Published: September 19, 2024

Abstract

Paediatric cardiac disease is an established cause of ischemic stroke in the neonatal and infantile groups. These diseases may be congenital or acquired. However, clinical myocarditis is in itself, relatively uncommon in older children. The most common pathogen is Coxsackie virus B. The offending agent instigates an immune response, which causes myocardial oedema with eventual systolic and diastolic dysfunction. Cardioembolic stroke can occur secondary to an intra-mural thrombus in a dysfunctional atrium or ventricle. We describe the case of an adolescent male with acute myocarditis complicated by a thromboembolic stroke. After initial management of acute pulmonary oedema and heart failure with restricted ejection fraction (HFrEF), the child developed seizure-like symptoms on the 10th day of hospitalization, prompting urgent neuro-radio diagnosis, which revealed acute infarcts in the cerebellum and frontal lobe of the cerebrum. We believe this case to be of clinical relevance because; 1) The diagnosis of an acute stroke in children is often delayed due to the atypical clinical presentation and often the absence of traditional stroke-like symptoms, and 2) There is a lack of sufficient high-quality evidence regarding the predictors and the immediate management of stroke in paediatric heart disease, as well as inadequate data on prevalence and incidence in paediatric cardioembolic strokes.

Keywords

Paediatric Ischemic Stroke, Adolescent Myocarditis, Ventricular Hypokinesia, Cardioembolic

1. Introduction

Paediatric myocarditis remains a clinical challenge. Initially, the diagnosis was based on histopathology, for example, the Dallas criteria [1], which was identified at autopsy. However, with time, the diagnostic focus has shifted from endomyocardial biopsy to dependence on clinical suspicion. This has largely been due to the invasive and low-sensitivity nature of an investigational biopsy [1]. With the developmental progress in the quality of cardiac magnetic resonance, an examination of the entire heart has gained a favourable response in the endeavour of diagnosing myocarditis [2] (**Figure 1**). The clinical syndrome may vary from insidiously hidden symptoms to heart failure, near-fatal arrhythmias, or cardiogenic shock. Typically, acute myocarditis presents with restricted ventricular function with or without dilation, recent presentation of heart failure, and viral infectious symptoms in the preceding weeks [3] [4].

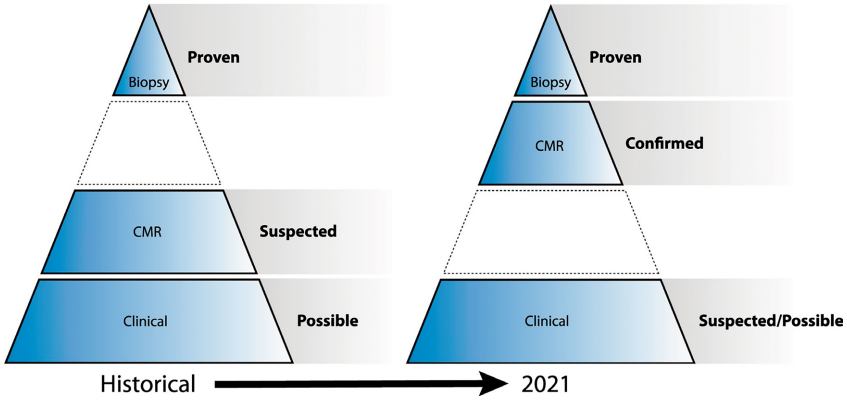

Figure 1. Paradigm shift in the definition of myocarditis.

There is an increased risk of acute ischemic stroke (AIS) in the paediatric population with cardiac disease. It has been specifically observed that children with certain pathologies, such as single ventricle pathophysiology and cardiomyopathy, are at an elevated risk of developing a cardioembolic stroke [5]. The risk of stroke in paediatric heart disease is well known, however, it continues to remain a conundrum in terms of prompt clinical diagnosis. This fact, compounded with an absence of high-quality evidence on the prevention and treatment of paediatric strokes, makes the anticipation of the latter in acquired paediatric heart disease extremely relevant even today. The relationship between acute stroke and cardiac disease in children is known, and certain types such as cyanotic congenital heart disease, are at a greater risk for precipitating a cardioembolic stroke. It is relevant to note that the majority of the studies generating incidences for stroke in paediatric heart disease are seldom multicentre studies [5]. Previously published research highlighting the prevalence of paediatric stroke in heart disease has reported ranges of 28% - 34% (Berlin Heart EXCOR VAD), 5% - 25% (preoperative congenital heart disease), 6% - 11% (endocarditis), and 4.8% (cardiomyopathy) [6]-[9].

It is pertinent to state that, paediatric myocarditis is often underestimated, with mild cases often being unreported, and hence, the exact incidence remains unknown. Studies have shown that non-ischemic dilated cardiomyopathy and heart failure can develop in nearly 50% of patients with acute myocarditis, carrying increased rates of mortality from dysrhythmias and elevated risk of thrombotic events, which can lead to venous and arterial embolism [10]. In spite of this, the rate of stroke in patients with myocarditis-associated heart failure is not well described. We present the case of a 16-year-old male with acute myocarditis and heart failure complicated by an acute cardioembolic ischemic stroke on Day 10 of illness.

2. Case Description

Presentation

A 16-year-old male with no medical co-morbid conditions presented to the Emergency Department (ED) of a tertiary care hospital in Mumbai with chest pain and productive cough for 5 - 6 days, progressing to dyspnea (NYHA class IV) for two days, associated with orthopnoea. There were no overt prodromal symptoms; fever, sore throat, palpitations, haemoptysis, vomiting, diarrhoea, and syncope were denied.

On arrival to the ED, the patient's vital parameters were heart rate (HR) 139 beats per minute, blood pressure (BP) 90/60 mm Hg, and respiratory rate (RR) 35 breaths per minute; oxygen saturation (SpO2) 79% on room air. On physical examination, there was no pallor; trachea was central, no jugular venous distension. His peripheries were clammy, with a delayed capillary refill. There was no evidence of oedema. The patient's heart sounds were normal, with no detection of a murmur; his chest findings were positive for diffuse bilateral inspiratory crepitations. The abdomen was soft and non-tender, without evidence of organomegaly. His neurological assessment was negative for focal deficits.

Investigations

A 12-Lead electrocardiogram (ECG) showed marked sinus tachycardia with voltage criteria for left ventricular hypertrophy (LVH) and left ventricular strain pattern (**Figure 2**). Transthoracic echocardiography (TTE) (**Figure 3**) revealed a dilated left ventricle (LV) and left atrium, generalised LV hypokinesia, left ventricular ejection fraction of 15%, grade II diastolic dysfunction, and a minimal rim of pericardial effusion. X-ray of the chest showed interstitial oedema (**Figure 4**).

Preliminary laboratory tests were done; haemoglobin: 13.3 g/dl, white cell count: 11,270/c.mm, platelets: 417 10^3/ul; creatinine: 0.8 mg/dL; sodium: 141 mEq/L, potassium: 4.4 mEq/L, chloride: 114 mEq/L; total bilirubin: 0.42 mg/dL (direct 0.17/indirect 0.25), serum albumin: 3.11 g/dL, alkaline phosphatase: 162 U/L, SGOT: 39 U/L, SGPT 18 U/L; total creatine phosphokinase: 429 U/L; antistreptolysin O: 7.8 IU/ml; C-reactive protein: <5.0 mg/L; high-sensitivity troponin-I: 199.4 pg/ml.

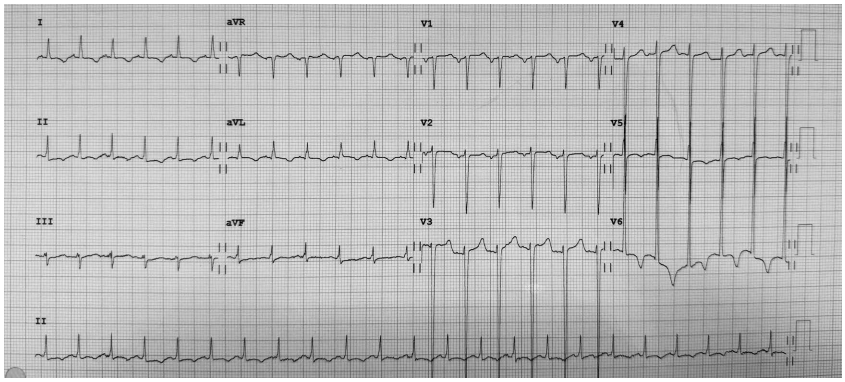

Figure 2. 12-Lead electrocardiogram meeting the Sokolow-Lyon criteria for left ventricular hypertrophy.

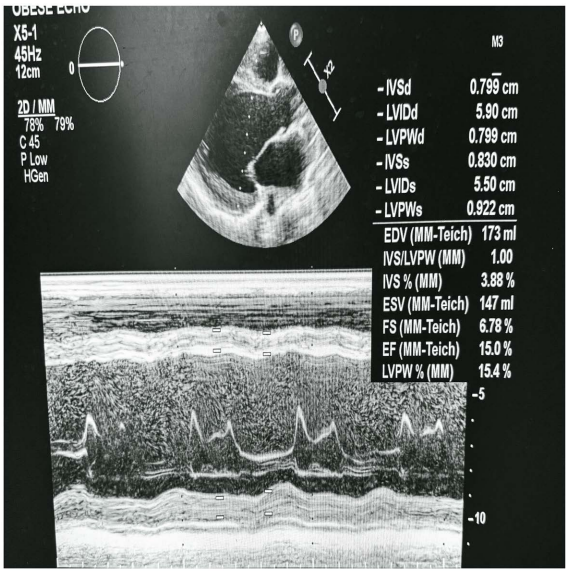

Figure 3. Transthoracic echocardiogram showing a dilated and hypokinetic left ventricle.

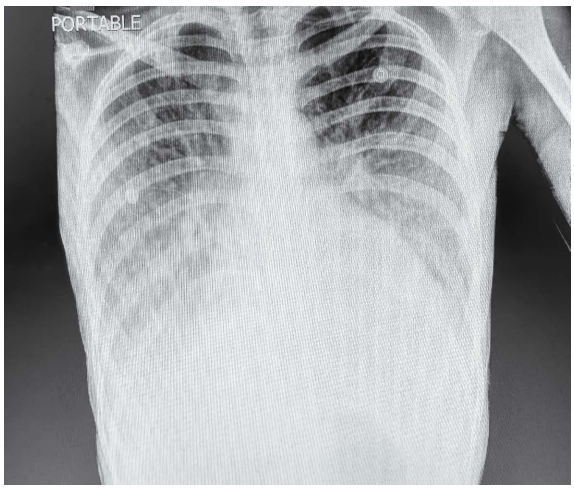

Figure 4. Antero-posterior radiograph of the chest showing peribronchial cuffing and perihilar haze, along with septal (Kerley) lines.

Contrast-enhanced cardiac magnetic resonance (CMR) imaging (done on Day 3 of hospitalization) showed a dilated left ventricular cardiomyopathy with elevated native T1 values and diffuse patchy oedema (Figure 5). As per the 2018 Lake Louise criteria, these findings were representative of acute myocarditis. Subtle patchy, linear mid-myocardial enhancement was seen in the basal and mid-segments without overt fibrosis. There was no infiltration, infarction or thrombus. Pericardium was normal, with a pericardial effusion measuring up to 1.5 cm in maximum thickness. The LV ejection fraction was 11%, with elevated volumes and normal right ventricle function.

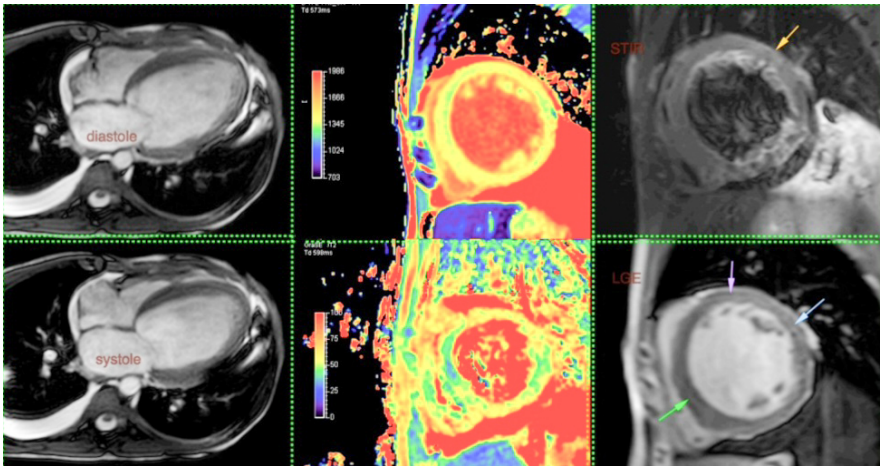

Figure 5. Contrast-enhanced CMR performed on the third day of hospitalization showed increased mid-myocardial enhancement in T1-weighted images.

Treatment

The patient was started on non-invasive ventilation (continuous positive airway pressure) in view of cardiogenic pulmonary oedema. With an expert opinion from a cardiologist, he was initiated on steroid therapy (parenteral methylprednisolone) along with torsemide, and an angiotensin receptor neprilysin inhibitor (sacubitril-valsartan). In addition to this, dapagliflozin and bisoprolol were used as adjuncts in the management of heart failure with reduced ejection fraction.

Outcome

Over the next few days in the Intensive Care Unit (ICU), the patient progressively improved; inflammation markers and biomarkers for myocardial necrosis showed a downward trend. He was gradually weaned off the non-invasive ventilation, and managed on supplemental nasal oxygen with marginal requirement. On the tenth day of admission, the patient exhibited generalized seizure-like symptoms. Being an unwitnessed event, it was difficult at the time to differentiate the episode from syncope; however, the episode was followed by complete resolution of symptoms without any residual focal neurologic deficit.

Magnetic resonance (MR) imaging of the brain was performed showing acute infarcts in the left cerebellum and the right frontal lobe of the cerebrum (Figure 6, Figure 7). MR angiography of the brain and neck was normal. Anticoagulation

therapy with low molecular weight heparin was started, and the patient was commenced on neuro-rehabilitation.

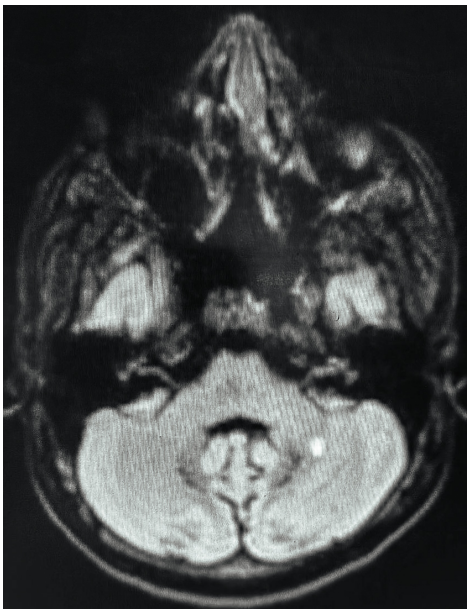

Figure 6. Diffusion-weighted imaging (DWI) showed marked focal hyper -intensity in the left cerebellum suggestive of an acute ischemic stroke.

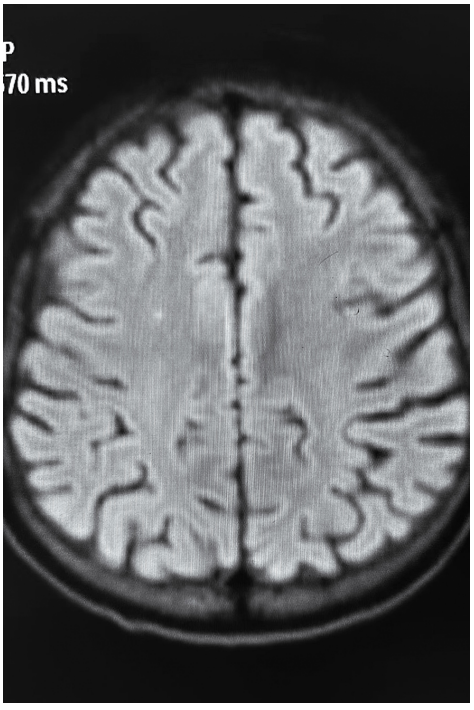

Figure 7. DWI magnetic resonance of the brain shows an acute infarct in the right frontal lobe of the cerebrum.

Follow-up

At the time of discharge from the hospital, the patient had developed residual

cardiomyopathy, though the follow-up echocardiogram showed an ejection fraction of 25% (slight improvement). He was continued on direct oral anticoagulants, until his next planned follow-up with his primary cardiologist.

3. Discussion

The exact incidence of paediatric myocarditis is not clearly known, with several cases being often asymptomatic or manifesting with symptoms that are atypical. A retrospective study from Finland conducted between 2004 to 2014 in patient population < 15 years of age reported an incidence of 1.95 per 100,000 [11]. In the United States of America, Vasudeva *et al.* in their retrospective study of myocarditis in age groups < 18 years showed an incidence of 0.80 per 100,000 [12]. A cohort study by Klugman *et al.* in 2005 evaluating paediatric discharges under 21 years of age diagnosed with acute myocarditis revealed a 0.05% prevalence [13]. In India, there are currently no large-scale cohort studies showing an accurate representation of the prevalence and incidence of paediatric myocarditis.

The cardiovascular and nervous systems are closely interconnected in the setting of myocarditis [14]. Patients suffering from myocarditis can experience central nervous system sequelae due to an array of mechanisms namely, embolism due to formation of mural thrombi within the cardiac chambers, and thrombosis secondary to heart failure and cardiomyopathy [15]. In paediatric congenital or acquired heart disease, thrombi within the ventricles are rarely identified on echocardiography after an acute ischemic stroke [16].

The incidence of stroke in patients with myocarditis-associated heart failure is unclear. The Rotterdam study of 2010 showed that the risk of acute ischemic stroke during the first month after diagnosis of heart failure increased approximately six times (HR 5.79, 95% CI 2.15 - 15.62) [17]. Our patient developed an acute ischemic stroke within 10 days of presentation of acute myocarditis with heart failure. Reviews of literature have not shown any evidence of stroke-manifestation within such an acute window period. In the International Paediatric Stroke Study cohort, Dowling *et al.* found that children with heart disease and acute ischemic stroke were more likely to have strokes in patterns that were bilateral, and involving both the anterior and posterior vascular territories, as against those without cardiac disease [18]. Typically, our patient had infarcts in the cerebellum as well as the frontal lobe of the cerebrum.

The diagnosis of acute ischemic stroke in children is frequently delayed. Often, during the periods of infancy and early adolescence, the usual signs of an acute stroke, such as motor limb weakness or sensory deficits, are lacking [18]. Generalized convulsions and focal seizures are a common presenting feature of stroke in the paediatric population, and insufficient awareness is often a reason for a lag in diagnosis [19]. It is pertinent to note that in our patient, seizure was indeed the presenting symptomatology.

Guidelines dictating the management of paediatric stroke in children with congenital or acquired heart disease are based on a relatively low level of evidence.

Expert opinion generating consensus is usually the driving force behind current recommendations. Optimum treatment of acute myocarditis is probably unknown, but the management approach varies according to disease severity. For acute presentation, the mainstay of therapy is largely supportive with anti-congestive medications because of the known natural improvement. Conventional therapy includes diuretics, angiotensin-converting enzyme inhibitors, beta-blockers, and low-dose digoxin [20]. Anticoagulant therapy is suggested for at least 3 months in patients diagnosed with an acute ischemic stroke resulting from cardioembolic causes (Grade 2C) [21]. The American Heart Association recommends anticoagulation for at least 1 year where there is risk of cardiac embolism or a high risk of recurrence (Class IIa, level of evidence C) [22].

4. Conclusions

Thromboembolic complications represent a sequelae of acute myocarditis, which, in the paediatric population, are relatively uncommon. Early recognition and prompt treatment would be the mainstay in mitigating morbidity and mortality that is often associated with these events.

This case highlights the importance of vigilance for ischemic strokes in the early stages of paediatric acute myocarditis, and the need for comprehensive risk assessment. Further research is warranted to elucidate the optimal therapeutic strategies for thromboembolic events in acute myocarditis in order to improve long-term outcomes in the paediatric population.

Consent

The authors of this article attest to the fact that patient identification has been kept entirely confidential and with complete anonymity. In the absence of informed consent, the primary author takes full responsibility for maintaining the confidentiality and autonomy of the patient described in this clinical case report.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Law, Y.M., Lal, A.K., Chen, S., Čiháková, D., Cooper, L.T., Deshpande, S., *et al.* (2021) Diagnosis and Management of Myocarditis in Children: A Scientific Statement from the American Heart Association. *Circulation*, **144**, e123-e135. https://doi.org/10.1161/cir.0000000000001001

[2] Butts, R.J., Boyle, G.J., Deshpande, S.R., Gambetta, K., Knecht, K.R., Prada-Ruiz, C.A., *et al.* (2017) Characteristics of Clinically Diagnosed Pediatric Myocarditis in a Contemporary Multi-Center Cohort. *Pediatric Cardiology*, **38**, 1175-1182. https://doi.org/10.1007/s00246-017-1638-1

[3] Williams, J.L., Jacobs, H.M. and Lee, S. (2023) Pediatric Myocarditis. *Cardiology and Therapy*, **12**, 243-260. https://doi.org/10.1007/s40119-023-00309-6

[4] Caforio, A.L.P., Marcolongo, R., Cheng, C., Baritussio, A., Tarantini, G. and Iliceto,

S. (2020) Clinical Presentation of Myocarditis. In: Caforio, A.L.P., Ed., *Myocarditis: Pathogenesis, Diagnosis and Treatment*, Springer International Publishing, 19-36. https://doi.org/10.1007/978-3-030-35276-9_2

[5] Sinclair, A.J., Fox, C.K., Ichord, R.N., Almond, C.S., Bernard, T.J., Beslow, L.A., *et al.* (2015) Stroke in Children with Cardiac Disease: Report from the International Pediatric Stroke Study Group Symposium. *Pediatric Neurology*, **52**, 5-15. https://doi.org/10.1016/j.pediatrneurol.2014.09.016

[6] Almond, C.S., Morales, D.L., Blackstone, E.H., Turrentine, M.W., Imamura, M., Massicotte, M.P., *et al.* (2013) Berlin Heart EXCOR Pediatric Ventricular Assist Device for Bridge to Heart Transplantation in US Children. *Circulation*, **127**, 1702-1711. https://doi.org/10.1161/circulationaha.112.000685

[7] Bertholdt, S., Latal, B., Liamlahi, R., Pretre, R., Scheer, I., Goetti, R., *et al.* (2013) Cerebral Lesions on Magnetic Resonance Imaging Correlate with Preoperative Neurological Status in Neonates Undergoing Cardiopulmonary Bypass Surgery. *European Journal of Cardio-Thoracic Surgery*, **45**, 625-632. https://doi.org/10.1093/ejcts/ezt422

[8] Venkatesan, C. and Wainwright, M.S. (2008) Pediatric Endocarditis and Stroke: A Single-Center Retrospective Review of Seven Cases. *Pediatric Neurology*, **38**, 243-247. https://doi.org/10.1016/j.pediatrneurol.2007.12.009

[9] Chen, K., Williams, S., Chan, A.K.C. and Mondal, T.K. (2013) Thrombosis and Embolism in Pediatric Cardiomyopathy. *Blood Coagulation & Fibrinolysis*, **24**, 221-230. https://doi.org/10.1097/mbc.0b013e32835bfd85

[10] Freedman, S.B., Haladyn, J.K., Floh, A., Kirsh, J.A., Taylor, G. and Thull-Freedman, J. (2007) Pediatric Myocarditis: Emergency Department Clinical Findings and Diagnostic Evaluation. *Pediatrics*, **120**, 1278-1285. https://doi.org/10.1542/peds.2007-1073

[11] Arola, A., Pikkarainen, E., Sipilä, J.O., Pykäri, J., Rautava, P. and Kytö, V. (2017) Occurrence and Features of Childhood Myocarditis: A Nationwide Study in Finland. *Journal of the American Heart Association*, **6**, e005306. https://doi.org/10.1161/jaha.116.005306

[12] Vasudeva, R., Bhatt, P., Lilje, C., Desai, P., Amponsah, J., Umscheid, J., *et al.* (2021) Trends in Acute Myocarditis Related Pediatric Hospitalizations in the United States, 2007-2016. *The American Journal of Cardiology*, **149**, 95-102. https://doi.org/10.1016/j.amjcard.2021.03.019

[13] Klugman, D., Berger, J.T., Sable, C.A., He, J., Khandelwal, S.G. and Slonim, A.D. (2009) Pediatric Patients Hospitalized with Myocarditis: A Multi-Institutional Analysis. *Pediatric Cardiology*, **31**, 222-228. https://doi.org/10.1007/s00246-009-9589-9

[14] Tahsili-Fahadan, P. and Geocadin, R.G. (2017) Heart-Brain Axis: Effects of Neurologic Injury on Cardiovascular Function. *Circulation Research*, **120**, 559-572. https://doi.org/10.1161/circresaha.116.308446

[15] Manea, M.M., Comsa, M., Minca, A., Dragos, D. and Popa, C. (2015) Brain-Heart Axis-Review Article. *Journal of Medicine and Life*, **8**, 266-271.

[16] D'Ambrosio, A., Patti, G., Manzoli, A., Sinagra, G., Di Lenarda, A., Silvestri, F., *et al.* (2001) The Fate of Acute Myocarditis between Spontaneous Improvement and Evolution to Dilated Cardiomyopathy: A Review. *Heart*, **85**, 499-504. https://doi.org/10.1136/hrt.85.5.499

[17] Alberts, V.P., Bos, M.J., Koudstaal, P.J., Hofman, A., Witteman, J.C.M., Stricker, B.H.C., *et al.* (2010) Heart Failure and the Risk of Stroke: The Rotterdam Study. *European Journal of Epidemiology*, **25**, 807-812. https://doi.org/10.1007/s10654-010-9520-y

[18] Dowling, M.M., Hynan, L.S., Lo, W., Licht, D.J., McClure, C., Yager, J.Y., *et al.* (2012) International Paediatric Stroke Study: Stroke Associated with Cardiac Disorders. *International Journal of Stroke*, **8**, 39-44. https://doi.org/10.1111/j.1747-4949.2012.00925.x

[19] Abend, N.S., Beslow, L.A., Smith, S.E., Kessler, S.K., Vossough, A., Mason, S., *et al.* (2011) Seizures as a Presenting Symptom of Acute Arterial Ischemic Stroke in Childhood. *The Journal of Pediatrics*, **159**, 479-483. https://doi.org/10.1016/j.jpeds.2011.02.004

[20] Atiq, M., Hoda, M. and Aslam, N. (2014) Effect of Intravenous Gamma Globulin on Short- and Mid-Term Clinical Outcome in Acute Viral Myocarditis in Children. *World Journal of Cardiovascular Diseases*, **4**, 39-44. https://doi.org/10.4236/wjcd.2014.42007

[21] Monagle, P., Chan, A.K.C., Goldenberg, N.A., Ichord, R.N., Journeycake, J.M., Nowak-Göttl, U., *et al.* (2012) Antithrombotic Therapy in Neonates and Children. *Chest*, **141**, e737S-e801S. https://doi.org/10.1378/chest.11-2308

[22] Roach, E.S., Golomb, M.R., Adams, R., Biller, J., Daniels, S., deVeber, G., *et al.* (2008) Management of Stroke in Infants and Children: A Scientific Statement From a Special Writing Group of the American Heart Association Stroke Council and the Council on Cardiovascular Disease in the Young. *Stroke*, **39**, 2644-2691. https://doi.org/10.1161/strokeaha.108.189696