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SPECIAL ISSUE ARTICLE

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Transatlantic medical consultation and second opinion in pediatric cardiology has benefit past patient care: A case study in videoconferencing

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Abstract

Background: Telemedicine is a rapidly evolving form of modern information and communication technology used to deliver clinical services and educational activities.

Objective: The aim of this article is to report and analyze our experience with transatlantic consultation via videoconferencing in pediatric cardiology.

Methods: In February, 2013, videoconferencing project was launched between a medium-volume pediatric cardiac center in Bratislava, Slovakia and subspecialty experts from a high-volume pediatric cardiac program at The Children's Hospital of Philadelphia (CHOP), USA. During 1.5–2 hours videoconferences, 2–3 patients with similar complex clinical scenarios were presented to CHOP experts. The main goal of the project was consultation on individual patients to validate, alter or radically change clinical management plans.

Results: From February, 2013 to January, 2017, 25 videoconferences occurred and 73 cases were discussed. The median patient age was 52 months (range; 1 day–30 years). Forty-six discussed cases were outpatients, 21 patients were in the intensive care unit and 6 patients were discussed post mortem. Thirty-one CHOP experts from different subspecialties participated actively in patient consultations. The most frequent recommendations were related to single ventricle, pulmonary hypertension or heart failure patients and intervention in complex and/or rare cardiac diseases. Specialists from CHOP agreed completely with the original care plan in 16% of cases. In 52% cases, adjustments to original plan were suggested. Radical changes were recommended in 30% of cases. Receiving institution adopted recommendations to the patient care fully in 79% and partially in 13% of patients.

Conclusions: Based on our 4-year experience we consider videoconferencing between medium-size pediatric cardiac center and subspecialty experts from a high-volume pediatric cardiac program a suitable form of medical consultations. Videoconferencing assists in clinical decision making for complex patient cases and serves as an effective educational tool to gain knowledge and experience "without borders."

KEYWORDS
telemedicine, pediatric cardiology, videoconferencing

1 | INTRODUCTION

Videoconferencing is a rapidly evolving form of modern information and communication technology used to deliver clinical services, information, medical image and data transfer, and educational activities over large and small distances.[1,2] Historically, videoconferencing has been the most common application of telemedicine care. For example, primary care providers can consult with medical specialists who are not available locally, medical specialists can evaluate patients in remote locations when distance is a barrier. Patients with limited mobility can receive medical consultations at home, or in their local primary care provider's office. Furthermore, videoconferencing allows health care professionals to conduct continuing education programs with attendees in distant or multiple locations. Patients and providers can use these technologies to take disease management courses or receive other important health information.[3–5]

Congenital heart defects are the most common birth defect. They affect 8–13 out of every 1000 newborns. The heart defects comprise a large number of anatomical variants and often, are associated with extracardiac anomalies. Furthermore, during the disease progress or as a consequence of treatment, additional acquired diseases and/or complications do occur. In such complex cases, decision making in diagnostic workup and treatment is neither standard nor straightforward. Despite the availability of medical literature and opportunities to attend professional meetings and conferences second opinion on individual patients is desirable.

During the past 25 years, telemedicine became a part of pediatric cardiology programs in different parts of world and helps to optimize care for children with congenital heart disease particularly in remote areas and developing countries. The shortage of experts in rural areas of large countries led to increasing use of remote data transmission and subsequent teleconsultation with experts from experienced high volume centers. Teleconsultations of live or store-and-transmit prenatal, neonatal and pediatric echocardiography became an important tool in the diagnosis or exclusion of pediatric cardiovascular diseases in patients admitted to remote hospitals.[6–10]

With growing quality and availability of data transmission, institutions have implemented videoconferencing specifically in the field of pediatric cardiology. Successful use of remote services includes review of cardiac magnetic resonance imaging (MRI),[11] monitoring and mentoring in catheterization procedures[12] including placement of cardiovascular implantable devices[13] or home monitoring of complex patients with congenital heart disease.[14,15]

There is limited experience or literature on international videoconferencing in pediatric cardiology. Cardiologists from the tertiary children's hospital "Agia Sofia" in Athens, Greece reported six videoconferences on rare cases of congenital heart disease with experts from Royal Brompton in London.[16] Munoz et al published a multicenter experience in videoconferencing at three hospitals in Colombia and one in Mexico with the Children's Hospital of Pittsburgh of the University of Pittsburgh Medical Center. Physicians provide medical consultation for pediatric critical care patients, with real-time interventions including echocardiography, adjustment of pacemaker settings and pharmacologic therapy. Their international telemedicine service in pediatric cardiac critical care was associated with shorter intensive care and hospital lengths of stay. The report concluded that real-time remote assistance may improve the medical care of pediatric cardiac patients treated in developing countries, and telemedicine interventions should focus on patients with higher RACHS-1 categories, lower-weight infants, and those with prolonged operative time and selective perioperative complications.[17,18]

The aim of this article is to report and analyze our experience with remote transatlantic consultation via videoconferencing between a tertiary medium-volume pediatric cardiac center in Bratislava, Slovakia and subspecialty experts from a high-volume pediatric cardiac program at The Children's Hospital of Philadelphia (CHOP), Philadelphia, PA, USA.

2 | METHODOLOGY

2.1 | Pediatric cardiac center Bratislava and cooperation with CHOP

The Pediatric Cardiac Center in Bratislava, established in 1992, provides complex care for pediatric and adult patients with congenital and acquired heart diseases covering the whole pediatric population of Slovakia. The development of the Pediatric Cardiac Center in Bratislava was initially supported by a five-year *Project HOPE* initiative funded by the U.S. Agency for International Development. Providing technical equipment and medical expertise from the Boston Children's Hospital the project improved care for Slovak children with complex congenital heart diseases.

Later, Dr. Gil Wernovsky, a member of Project HOPE team, was appointed Director of Pediatric Cardiac Intensive Care at CHOP and the American—Slovak cooperation continued through the Cardiac Center at CHOP. Observerships for Slovak physicians and nurses at CHOP helped implement changes in the pediatric cardiac programs in Slovakia, including the use of cardiac computer tomography, cardiac magnetic resonance, exercise training, simulation training, and neurocardiac care programs. Slovak attendance at the annual "CHOP Updates on Pediatric and Congenital Cardiovascular Disease Conference" provided a continuous source of information on the latest innovations in management and healthcare delivery for pediatric cardiovascular diseases.

Simultaneously with the above initiatives the Slovak and CHOP cardiac teams met at the Salzburg Medical Seminars and Satellite Symposia organized the American-Austrian Foundation. Experts from CHOP give state-of-art lectures and workshops for an international group of doctors during one-week seminars in Salzburg, Austria. Two-day Satellite Symposia were held in Bratislava in 2012 and 2015.

2.2 | Videoconferencing between Bratislava and CHOP

The videoconferencing project between the Pediatric Cardiac Center, Bratislava and CHOP was based on an offer of technical assistance

from the US Embassy Bratislava. The technical equipment available with in the US Embassy allowed transfer of high quality echocardiographic, angiographic, computed tomography (CT), and MRI data for videoconferencing. Following an agreement for medical consultations between CHOP and the Pediatric Cardiac Center, Bratislava, and an agreement between the Information Technology Departments of the US Embassy, Bratislava and CHOP, videoconferencing was launched in February, 2013. Dr. Lee Vogel, CHOP attending pediatric cardiologist, is the Director of the project.

Physician consultants and trainees from the Bratislava Pediatric Cardiac Center participated in all the videoconferences. Several videoconferences, with a multidisciplinary character (congenital diaphragmatic hernia, adults with congenital heart disease, pulmonary vein atresia), were attended by colleagues from relevant specialty teams, both to contribute their knowledge and to learn new approaches. In addition videoconferences were joined by adult cardiologists, experts from the Slovak National Transplantation Program and other colleagues from the Children's University Hospital Bratislava including general pediatricians, critical care physicians, pediatric surgeons, and neonatologists.

Videoconferences are organized on monthly basis. At each 1.5–2 hours conference 2–3 Slovak cases with similar complex clinical scenarios (for example, protein losing enteropathy, patients after heart transplant etc.) are presented to CHOP subspecialists. Relevant patient data are provided in PowerPoint (Microsoft Co., Redmond, WA, USA) presentations together with static and dynamic echocardiographic, angiographic, CT and MRI images. A standard scenario includes a Slovak trainee delivered presentation with a Slovak Attending consultant review that includes the questions of interest. Then, the CHOP team discusses their diagnostic and therapeutic approach. Depending on the topic, a didactic review and/or general guidelines are provided. When appropriate, brief literature reviews are presented and CHOP subspecialists add an experiential prospective to the literature.

Email communication is used both before and after the videoconference to provide additional data. Following each videoconference, a debriefing session took place in Bratislava and data obtained from CHOP experts were stored electronically. Videoconferencing leaders at CHOP and Bratislava summarized the recommendations and benefit of each encounter.

Clinical benefit of videoconferences on clinical decision making was assessed as follows: (1) Agreement with care plans; (2) Agreement with care plans and adjustments; (3) Significant divergence from current plans; (4) Never seen before by CHOP experts. Acceptance of recommendations by receiving institution was evaluated as follows: (1) Full adoption to care; (2) Partial adoption to care; (3) Continuation of the original plan. Ethics Committee of The National Institute of Cardiovascular Diseases approved the consultations and the study.

3 | RESULTS

From February, 2013 to January, 2017, 25 videoconferences occurred and 73 cases (63 individual patients) were discussed. The median patient age was 52 months (range; 1 day–30 years). At the time of consultation, the majority were outpatients (N = 46; 63%), 21 patients were in the ICU (27%) and 6 patients (11%) were discussed post mortem. Nine patients were repeatedly discussed to describe and evaluate the effect of therapy and discuss further management options. Complex clinical scenarios, as in multiple peripheral pulmonary stenosis, pulmonary venous atresia or recurrent stenosis, heart transplantation in a sensitized patient, congenital diaphragmatic hernia requiring ECMO support, pulmonary hypertension refractory to standard treatment were discussed (Table 1). Thirty-one CHOP experts from different

TABLE 1 Diagnoses of patient cases presented at videoconferences

Patient diagnoses	N = 73
Single ventricle	14
Pre-Fontan	5
Failing Fontan (HLHS or heterotaxy)	9
Atrioventricular septal defect (complex/dysbalanced)	10
Partial	4
Complete	6
Pulmonary vein anomalies	10
Complex total/partial anomalous pulmonary venous return	4
Stenosis	3
Atresia	3
Chronic heart failure	7
Pretranpslant	4
Posttransplant	3
Pulmonary hypertension	6
With congenital heart disease	4
Without congenital heart disease	2
Congenitally corrected transposition of great arteries	6
D-transposition of great arteries, complex	4
Peripheral pulmonary artery stenosis	4
Congenital diaphragmatic hernia + ECMO	2
Coronary artery anomalies	2
Atresia of left coronary artery	1
Anomalous left coronary artery from pulmonary artery	1
Ebstein anomaly	2
Congenital heart disease + severe lung injury	2
Congenital complete atrioventricular block + prematurity	1
Idiopathic giant right atrium	1
Shone syndrome	1
Congenital tracheal stenosis + pulmonary sling	1

Abbreviations: ECMO, extracorporeal membrane oxygenation; HLHS, hypoplastic left heart syndrome.

TABLE 2 Subspecialties of CHOP consultants at videoconferences (2013–2017)

Subspecialty	n
Pediatric cardiology	16
Heart failure / transplant	3
Single ventricle	3
Cardiac catheterization	2
Echocardiography	2
Pulmonary hypertension	2
Cardiac intensive care	2
Electrophysiology	1
Exercise testing	1
Adult cardiology	5
Pediatric cardiac surgery	2
Neonatology	2
Nurse practitioners	2
Pediatric surgery	1
Exercise training physiology	1
Pediatric hepatology	1
Pediatric neurology	1

subspecialties participated actively in patient consultations depending on specific clinical problems (Table 2). As a result of 25 videoconference consultation, 73 recommendations were proposed (Table 3). Specialists from CHOP agreed completely with the original care plan in 16% of cases. In 52% cases, adjustments to original plan were suggested. Radical changes were recommended in 30% of cases (N = 20). These include significant divergence from original therapeutic plans in 7 patients with severe pulmonary hypertension (operability of shunt lesion, pharmacological therapy, timing of intervention, pulmonary vein stenosis and congenital diaphragmatic hernia management) and 5 patients evaluated for heart transplant candidacy and posttransplant vasculopathy (appropriateness for transplant in failing single ventricle circulation and severe ventricular dysfunction, and therapy of cardiac allograft vasculopathy). A change in interventional strategy was proposed for additional 6 patients (single vs biventricular approach, catheter intervention for unilateral pulmonary vein atresia and for atypical anomalous pulmonary venous return). Different diagnostic and intensive care plan was suggested in a patient with chronic respiratory failure and in a newborn with increased cardiac biomarkers.

Receiving institution adopted recommendations to the patient care in 79% (N = 53) fully and in 13% (N = 9) of patients partially. Limited adoption of recommendations was due to additional data obtained following videoconference from catheterization study and genetic testing (four patients), transfer to other hospital (three patients) and clinical improvement (two patients).

4 | DISCUSSION

The reasons for collaboration between the Slovak Center and CHOP are several: (1) the Slovak Pediatric Cardiac Center is a medium-volume center and is the only center in the country. Therefore, opportunities for professional advancement and the potential for exchange of experience within the country are limited; (2) the CHOP Cardiac Center is a high-volume center with a large number of experts. CHOP maintains teams of highly trained cardiologists and surgeons, with an extensive subspecialty expertise as in Pulmonary Hypertension, Heart and/or Lung Transplant, Single Ventricle Monitoring and Survivorship, Hypertension and Vascular Evaluation, and so forth; (3) the CHOP subspecialists benefit from exposure to vastly different cardiac disease presentation and natural history. It is challenging, enlightening and rewarding to evaluate and adapt North American protocols to accommodate the skills and resources of an emerging program. There is the belief that the CHOP subspecialists are gaining as much as they are giving.

Videoconferencing used for peer-to-peer clinical services, such as collegial exchanges or case consultations, can be divided into three broad categories: store-and-transmit consultation, scheduled consultation, and just-in-time or on demand consultation.[3] Our videoconference consultation takes the form of scheduled consultations on a monthly basis. However, videoconferences were omitted at special

TABLE 3 Outcome of videoconference consultations: agreement with/divergence from original care plans and adoption rate by receiving institution

		Acceptance of recommendations by receiving institution		
		Recommendation adopted to care		
Main recommendation from CHOP	N = 67[a] (%)	Fully; N (%)	Partially; N (%)	Original care plan N (%)
Agreement with care plans	11 (16%)	11 (100%)	NA	NA
Agreement with care plans and adjustments	35 (52%)	27 (77%)	6 (17%)	2 (6%)
Significant divergence from current plans	20 (30%)	15 (75%)	3 (15%)	2 (10%)
Never seen before by CHOP	1 (2%)	0 (0%)	0 (0%)	1 (100%)
In summary		53 (79%)	9 (13%)	5 (8%)

Abbreviations: CHOP, Children's Hospital of Philadelphia; NA, not applicable.
[a]Only cases alive at the time of consultation analyzed.

occasions and holiday time. If needed, urgent cases were discussed with CHOP experts through email and telephone calls.

The main goal of this videoconferencing project was consultation on individual patients to validate, alter or radically change clinical management plans. There was no attempt to video-monitor diagnostic tests and therapeutic interventions directly. The benefits for the patients discussed at videoconferences were limited to novel therapeutic approaches, modifications of existing treatment, cancellation/postponing of planned therapy or transition to "comfort care."

The exact impact of this videoconferencing project on improvement of medical care is difficult to calculate as the discussed cases were rare and/or were associated with significant comorbidities. Outcome was assessed according to (1) agreement with or divergence from original care plans and (2) acceptance rate by receiving institution. Significant divergence from current diagnostic and therapeutic plans was observed in 30% of cases. The recommendations were fully or partially adopted in 79% and 13% of cases, respectively.

Knowledge and experience gained from experts is also used for management of future patients. Therefore, videoconferencing serves as an educational tool. A common comment of participants focused on the specialist's integrating steps between the presented data and the final recommendations. As the Slovak Pediatric Cardiac Program evolved rapidly it was possible to adopt many complex interventions; however, there were very few possibilities to learn the evaluation and integration methodologies that are the cornerstones to effective consultation in America. Furthermore, videoconferencing is considered an active form of learning, as it requires rigorous preparation, formulation of relevant clinical questions, effective discussion, practical application, information sharing and teaching of others.[19] Videoconference attendance has been approved by the Slovak Medical Chamber as a continuous medical education activity in Pediatric Cardiology since June 2014.

Organizing a videoconferencing session at the local conference is another way to use this communication technology for educational purposes. Videoconferences with CHOP experts were incorporated into the scientific agenda of Slovak National Conference in Pediatric Cardiology. The equipment was arranged and financially supported by US Embassy Bratislava. Based on our positive experience with videoconferencing in the area of Pediatric Cardiology, this project has been extended to cooperation between Pediatric Hematology and Oncology Departments at Children's Hospital in Bratislava and CHOP (since September 2015).

Despite the above-mentioned benefits, participants also need to be aware of the *limitations* of this new technology. Videoconferencing is a technologically synchronous activity. Attendees need to meet at specified times and locations. While videoconferencing can bridge the distance in the creation of borderless e-learning communities, it cannot bridge time. Between US and Europe the time difference of 6 hours is an issue. Set up and participation during, or outside of working hours should be considered. Ideally, videoconferencing takes place in the hospital. For this reason, US Embassy Bratislava donated the videoconferencing device to Pediatric Cardiac Center (June 2016). If the equipment is not available, a remote location may serve the purpose, especially for nonacute patient cases and education purposes. Stable event structure comprising patient presentation followed by discussion provides a crucial situational awareness and is an effective method of assuring participation of a core group at each site.

The consultation of complex cases requires medical experts. Some issues and topics require a specific expert, therefore advance organization of the session must occur according to availability and be planned even more in advance than regular encounters. Language barriers and the ability to discuss and to present complex physiologic principles and therapeutic approaches without risk of being misunderstood are real risks to success. Furthermore, the importance of pre-videoconference and post-videoconference communication cannot be overstated. This has been our effective way to finally correct misconceptions that otherwise would affect patient care.

Creation of an atmosphere devoid of criticism or blame has helped to promote constructive discussion and a clear understanding of the ideological and structural limitations since American medical practice may not work in other locations. Delivering by email the patient case presentation to CHOP participants 2–3 days in advance allows timely correction of ambiguities so the videoconferencing session runs fluently. Lack of language knowledge may exclude some team members from participation but for those who attend the language barrier can be overcome with active listening. Discussion leaders can paraphrase the message they heard and check out the accuracy of their assumptions.[20]

5 | CONCLUSIONS

Based on our 4-year experience we consider videoconferencing a suitable form for medical consultations that assists in clinical decision making for complex patient cases. Furthermore, videoconferencing serves as an effective educational tool in pediatric cardiology as it presents active learning through real problem solving. International videoconferencing is an opportunity to gain knowledge and experience "without borders" and participants need to be aware of the unique challenges to maximize the benefit from this new technology.

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CONFLICT OF INTEREST

None

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