heart to heart
INTERNATIONAL CHILDREN'S MEDICAL ALLIANCE

INTO *the* HEARTLAND CAMPAIGN

SITE: KALININGRAD, RUSSIA
DISTRICT: NORTHWESTERN
COLLABORATION LAUNCHED: 2013

APRIL 7 – 15, 2017
PEDIATRIC TEAM
FOCUS: EBSTEIN ANOMALY

En route to Kaliningrad via Moscow Members of Heart to Heart's team visit the famed Red Square during a stopover in Moscow. Red Square is home to quintessential Russian landmarks including Saint Basil's Cathedral, the Lenin Mausoleum, and the Kremlin. Shown (left to right): Patrick, Ann, and Joseph Dearani, MD; Albina Popova; Irma Ozashvili; Hannah Hunter; Grace Arteaga, MD; Eric Eggler, RN; Laurie Utne, RN; and Caitlin Blau.

VALVULAR HEART DISEASE AMONG CHILDREN

Worldwide, one out of every 100 children is born with a congenital heart defect (also known as congenital heart disease or CHD), affecting more than one million babies around the globe each year. Some defects are relatively minor: a small atrial septal defect – a tiny hole between the upper two chambers of the heart – may close on its own with no medical or surgical intervention. Others are severe and require immediate surgical intervention – within a baby's first year, months, or even days of life – if the child is to be saved. Of all known congenital heart defects, approximately 25% affect the heart's valves, falling into a category known as valvular heart disease (see table, page 2). Valvular heart disease affects children worldwide; estimates range as high as five million.

Surgically treating valvular disease in children is particularly challenging; as they grow and change physically and their bodies increase in size, their hearts grow proportionally. However, if a young child's native heart valve is replaced with an artificial valve (bioprosthetic or mechanical), the child will very likely require additional open heart surgery to re-replace that same valve later in life. This is because an artificial replacement valve always remains the same size (it does not grow with the child). Therefore, when treating young children with valvular heart disease, it is preferable to repair a valve whenever possible. Using this approach, we can minimize the number of open heart operations a child with valvular disease must undergo during his lifetime.

HEART TO HEART 2017 KALININGRAD TEAM **Children's Healthcare of Atlanta:** Brenda Jarvis, PCICU nurse **Mayo Clinic:** Dr. Grace Arteaga, PCICU intensivist; Caitlin Blau, perfusionist; Dr. Bryan Cannon, cardiologist (electrophysiology); Dr. Frank Cetta, cardiologist; Dr. Joseph Dearani, surgeon; Eric Eggler, PCICU nurse; Laurie Utne, PCICU nurse; Joan Wobig, surgical assistant **UC Davis Medical Center:** Olesya Dushkova,* surgical technician **Heart to Heart:** Josie Everett,* executive director; Hannah Hunter, interviewer and photographer; Irma Ozashvili,* interpreting coordinator; Albina Popova,* mission coordinator; Dr. Nilas Young, founder and medical director.

*Russian-English bilingual

Traveling hundreds of miles for treatment Saveliy (left) is a rambunctious five-year-old who loves stuffed animals. Iskander is a shy 10-month-old. Both boys traveled more than 1,000 miles to undergo life-saving surgery for their congenital valvular heart disease. Saveliy traveled nearly 1,600 miles! The Heart to Heart-Kaliningrad team successfully performed Cone reconstructions on both Saveliy and Iskander.

Pediatric valve repair and replacement

There are multiple benefits to repairing valves in young children with valvular disease. As mentioned, repaired native valves grow in size proportionately with the child as he matures to adulthood. Moreover, valve repair does not require a child to take anti-rejection medication, which is not yet accessible to most children around the world. Additionally, in developing economies, overall per patient costs for treating valvular disease are lower because there is no need to purchase imported replacement valves. However, it is important to note that after valve repair surgery, some children will require valve replacement in the future. Because each subsequent open heart surgery carries increased risk to patients, delaying valve replacement in children for as long as possible is advisable. One of several key teaching points during Heart to Heart's surgical-educational mission and national symposium in Kaliningrad was when to repair or replace the tricuspid valve in children with a rare form of valvular heart disease known as Ebstein anomaly.

What is Ebstein anomaly?

Ebstein anomaly was named after German physician Wilhelm Ebstein, who first described the condition in a 19-year-old laborer, Joseph Prescher, in 1866. It is a rare type of congenital valvular disease of unknown cause. In Ebstein anomaly, the tricuspid valve – the valve between the two right heart chambers (right atrium and right ventricle) – is malformed and does not work properly. Blood often leaks back through the tricuspid valve, causing a child's heart to work less efficiently.

Congenital and valvular heart disease

The table below lists types of defects, their prevalence, and whether they affect the heart's valves

TYPE OF CHD	PERCENT OF TOTAL CHD	VALVULAR DISEASE?
Ventricular septal defect	40.9	
Atrial septal defect	9.7	
Pulmonic stenosis	7.6	Yes
Patent ductus arteriosus	7.1	
Tetralogy of Fallot	5.3	Yes
Coarctation of aorta	4.5	
Atrioventricular canal	3.6	Yes
Aortic stenosis	3.5	Yes
D-transposition of the great arteries	3.5	
Hypoplastic left heart syndrome	2.5	
Double outlet right ventricle	2.2	
Hypoplastic right heart syndrome	2.0	
Ebstein anomaly	1.5	Yes
Pulmonary atresia	1.3	Yes
Truncus	1.2	Yes
Single ventricle	1.2	
TAPVC	1.1	
Tricuspid atresia	1.1	Yes

Does not include bicuspid aortic valve (BAV).

Source: Table 1 from Julien Hoffman and Samuel Kaplan, The Incidence of Congenital Heart Disease, JACC 2002: Vol. 39, No. 12, p. 1896.

Valvular heart disease affects patients of all ages Yulia (left) is a sociable 17-year-old who loves dancing. She traveled with her mother from Tatarstan, an autonomous republic in Russia, nearly the size of Ireland. Sasha is a playful three-year-old boy from Nizhny Novgorod. Founded in 1221, Nizhny was a secret city known as "Gorky" during the Soviet Era. Both children successfully underwent Cone reconstructions via open heart surgery for tricuspid valve repair.

Ebstein is diagnosed in 0.5-1.5% of all children born with heart defects. The severity varies from person to person. Some children with Ebstein anomaly experience shortness of breath and fatigue – especially during and after physical activity. Main symptoms of Ebstein include arrhythmias, when the heart rhythm becomes abnormal, and cyanosis, when lips, fingers, and toes turn a bluish color due to insufficient oxygen reaching the body's extremities. Some children exhibit symptoms in infancy, while others live to adulthood with no symptoms.

Due to the wide clinical and anatomical variability among Ebstein patients, and the rarity of this heart defect, very few specialists worldwide have had sufficient experience to treat this cohort of patients confidently.

Cone reconstruction for valve repair

Heart to Heart's team – made up of specialists predominantly from the Mayo Clinic – was led by doctors Joseph Dearani and Frank Cetta and complemented by veteran Heart to Heart volunteers from Children's Healthcare of Atlanta and UC Davis Medical Center. They traveled to Russia to give a master class on how to manage the medical and surgical care of patients suffering from Ebstein anomaly. We chose our partner site in Kaliningrad as hosts of the national symposium because of their strong surgical program, their exceptional organizational skills, and their commitment to advancing cardiac care nationwide. Cardiac specialists traveled from all over Russia to attend lectures addressing the anatomy and physiology of this rare valvular condition, to review diagnostic images in a conference setting, and to observe in real-time eight open heart procedures to repair malformed tricuspid valves, the hallmark of Ebstein anomaly. The open heart surgeries were streamed live to an overflow audience from across the country (see map, page 4).

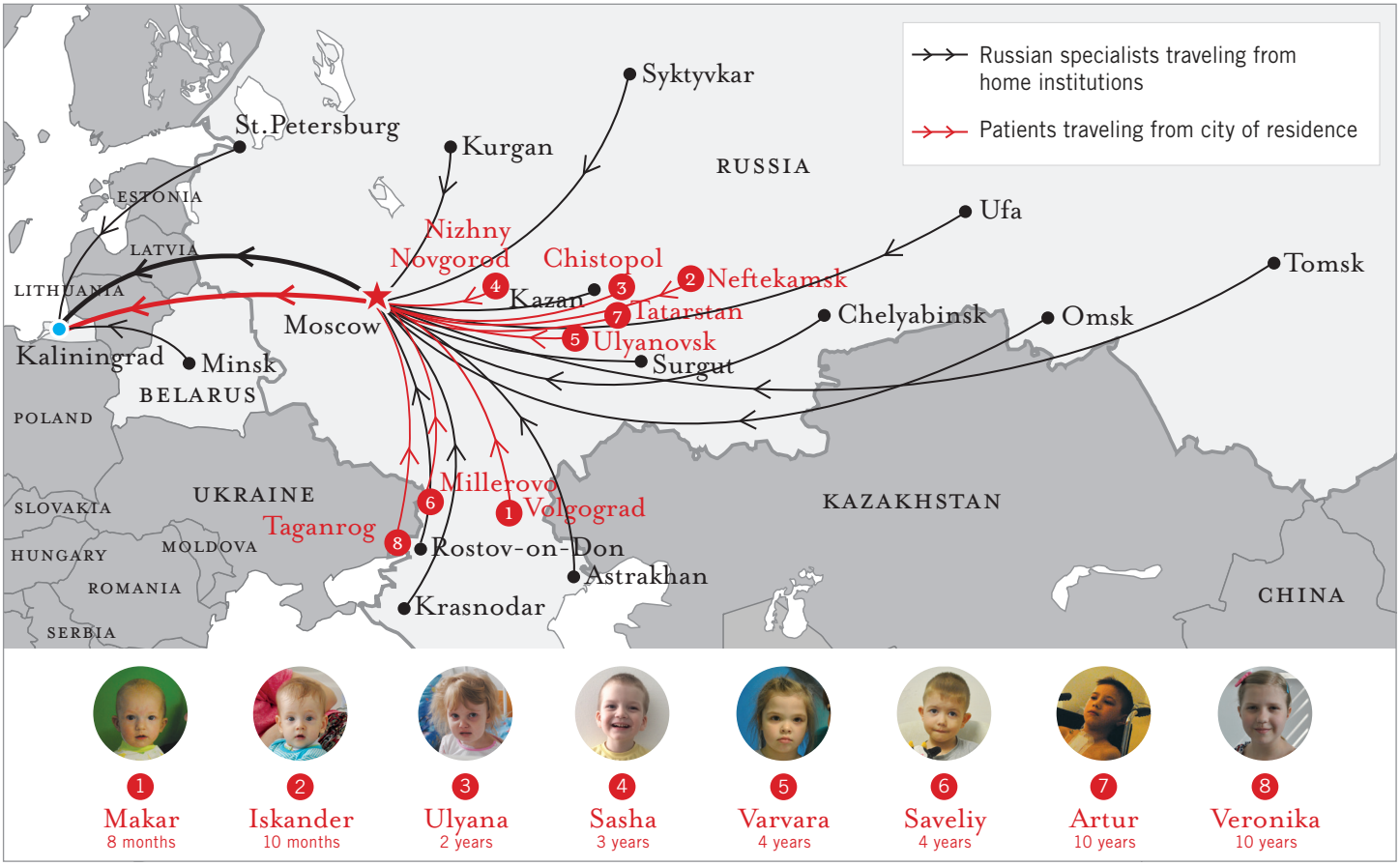
The Mayo Clinic: Ebstein experts

The Mayo Clinic in Rochester, Minnesota is known internationally for its expertise in the treatment of Ebstein patients. Mayo surgeons have been performing these open heart repairs for 45 years, and have treated a larger volume of Ebstein patients than any other institution in the world. Nearly 1,300 Ebstein patients have undergone surgery there, and several thousand more receive ongoing medical care from Mayo cardiologists.

During the 1960s, most attempts to repair the tricuspid valve in Ebstein patients were unsuccessful, and prosthetic valve replacement was the standard approach. In 1972, Dr. Gordon K. Danielson was one of the first surgeons to successfully repair the tricuspid valve of an Ebstein patient. Dr. Danielson, a Mayo Clinic cardiothoracic surgeon and mentor to Dr. Dearani, has played a key role in Mayo's unique institutional knowledge in the treatment of this defect. Danielson's technique was performed on hundreds of patients from 1972 up to 2007.

Many specialists have tried to modify the Danielson repair, also known as the monocusp procedure. In 1980, Dr. Alain Carpentier proposed another technique for Ebstein valve repair, known as the Carpentier procedure. Dr. Jose Pedro da Silva modified the Carpentier repair, inventing what is now called the Cone reconstruction. For more than a decade, Dr. Dearani has further expanded treatment options through modifications of the Cone reconstruction.

HEART TO HEART'S NATIONAL SYMPOSIUM ON EBSTEIN ANOMALY



Meet the children During Heart to Heart's mission to Kaliningrad, eight Cone repair surgeries were performed on children ranging from eight months to 10 years of age (see photos above). More than 40 Russian medical professionals traveled from all over the country to attend the symposium (see map above); and pediatric patients, some from more than 2,500 miles away, came to be evaluated as surgical candidates.

Teaching the Cone reconstruction in Kaliningrad

The primary goal of the Cone procedure is to reconstruct the malformed tricuspid valve – a realistic possibility for most Ebstein patients. The secondary goal is to enhance the function of the right ventricle, where the muscle can be diseased and very thin. Dr. Dearani and his Mayo team have performed Cone reconstructions on approximately 300 patients since June 2007. This operation greatly improves the valve function by reducing or eliminating valvular insufficiency.

At daily case conferences during our mission in Kaliningrad, each surgical candidate's heart anatomy and physiology were carefully assessed by reviewing patient histories and echocardiography and/or diagnostic catheterization images. Children thought to have favorable anatomy for valve repair were scheduled for open heart surgery. However, even with some of the world's best experts in the room, it was hard to say with 100% accuracy whether or not a particular child's valve could be repaired. For two of our patients, appropriately-sized replacement bioprosthetic valves were on hand in the operating room in case replacement proved to be the better option. Fortunately, all of the Cone reconstructions were successful, and our patients recovered well.

During the busy week-long training mission and symposium, the joint Heart to Heart-Kaliningrad team performed eight Cone procedures on children ranging from eight months to 10 years of age; three diagnostic catheterizations; and three transesophageal electrophysiologic studies. Together, the joint team also physically examined and consulted on more than 60 patients, half of whom had Ebstein anomaly.

Cardiologists and surgeons from all over the country attended our national symposium. Doctors Arteaga, Cannon, Cetta, and Dearani of the Mayo Clinic presented lectures and shared their expertise in Ebstein diagnosis and treatment alongside Russian colleagues Dr. Vladimir Bolsunovsky from Heart to Heart's partner site in St. Petersburg, and Dr. Evgeny Krivoshchekov from our partner site in Tomsk, Siberia. (Dr. Krivoshchekov learned the Cone reconstruction while visiting the Mayo Clinic in 2011 and observing Dr. Dearani's in the operating room.)

The symposium fostered tremendous educational interaction among Russian and American colleagues. In addition to having the opportunity to observe Cone procedures in real-time, visiting surgeons posed questions each day to the Heart

Real-time teaching of valve repair surgery Heart to Heart guest surgeon, Joseph Dearani, operates on an Ebstein patient alongside Vyacheslav Belov, lead pediatric cardiac surgeon at the Kaliningrad Federal Center, our partner site. During the mission, Dr. Dearani shared his expertise on how the Cone procedure can be modified to repair each patient's unique heart anatomy. Each year in Russia alone, nearly 5,000 children are born with valvular heart disease.

to Heart-Kaliningrad surgical team about techniques used during each open heart case. When discussing Cone repair with the more than 40 visiting specialists, Dr. Dearani advised:

> *"If, after looking at images you obtain via transesophageal echocardiography immediately after attempting your Cone repair, you don't like what you see...if there is still too much regurgitation, you need to be willing, while the patient is still on the operating table, to go back in and re-repair."*

After surgery, Ebstein patients require lifelong monitoring to assess tricuspid valve function and heart rhythm.

Continued cardiac advances throughout Russia

Every year in Russia, more than 19,000 babies are born with congenital heart defects, with over one third of them requiring cardiac intervention within their first year of life if they are to survive. **Among these children, nearly 5,000 are born each year with valvular heart disease.**

For over 25 years, Heart to Heart pediatric cardiac specialists from across the United States have traveled to our partner sites throughout Russia to provide advanced education and clinical training to nascent cardiac teams. Heart to Heart is thrilled to have played a role in the phenomenal progress in the treatment of CHD nationwide. **Since 1989, we have seen the annual volume of pediatric open heart cases in Russia grow from about several hundred to more than 8,000 per year.** Importantly, access to pediatric cardiac care has expanded from the capital city of Moscow to cities throughout the heartland, where each year thousands of children can now undergo surgery at more than six regional pediatric heart centers.

Without the year-round hard work and dedication of our talented Russian colleagues, advances in nationwide cardiac care would not be nearly as tangible. Effective collaboration between our Russian and American colleagues has led to outstanding progress in developing new teams and new self-sustaining programs. By continuing to share our expertise with Russian medical professionals, more children will be given a second chance at life.

At Heart to Heart's six Russian partner sites, nearly 2,500 children with CHD – around 600 of whom have valvular disease – are being surgically treated each and every year. This thriving cardiac care network is made possible thanks to our fantastic medical colleagues, dedicated volunteers, and generous funding partners.

PATIENT PROFILE

Child	Veronika Z.
Date of birth	February 27, 2007
Weight	68 lbs
Home	Taganrog (1,500 miles from Kaliningrad)
Diagnosis	Ebstein, s/p tricuspid valve annuloplasty, Glenn (2008)
Open heart surgery	Cone repair April 13, 2017
Discharged from PCICU	April 14, 2017

Veronika's story: a lifelong search for surgical treatment

Veronika is a shy, intelligent 10-year-old girl. She and her mother Anna traveled from Taganrog, a port city in the Southern Federal District of Russia. Veronika lives with her mother, father, and grandparents. Her mother works as a customs inspector, and her father works in information technology at a bank. In school, Veronika's favorite subject is math; in her free time she enjoys drawing. Inspired by her father, she dreams of growing up and working with computers.

Veronika was diagnosed with a congenital heart defect in utero. She was born in Rostov-on-Don in February 2007. Shortly after birth, the doctors there diagnosed her with Ebstein anomaly. Soon thereafter, she was diagnosed with Wolff-Parkinson-White syndrome, a type of arrhythmia that sometimes accompanies an Ebstein diagnosis. Veronika was prescribed medication to relieve her heart rhythm issues, but local pediatricians were unsure if surgery was possible for her. The family received conflicting medical advice, and some surgeons would not consider valve repair.

While she was still an infant, Veronika began to experience instances of tachycardia (dangerously rapid heart rate). The medication she was prescribed was not working. Veronika spent months at various hospitals as doctors tried to figure out which treatments might improve her condition. She had to undergo multiple cardiac ablations before her symptoms were under control. (A cardiac ablation is a minimally-invasive procedure used to intentionally scar small targeted areas of heart tissue that contribute to arrhythmias. Once the tissue is scarred, it can no longer conduct unwanted abnormal electrical signals within the heart.) Veronika traveled with her family to various centers throughout Russia: Samara, Tomsk, and Moscow. In 2008, Veronika had multiple open heart operations, including a Glenn procedure and tricuspid valve annuloplasty.

For more than six months prior to Heart to Heart's arrival, Veronika was very sick. She complained of dizziness even while sitting in class. Exercising was completely out of the question; she could barely walk up a flight of stairs. Anxious about her daughter's condition, Veronika's mother wrote to Heart to Heart asking if we could do anything to help. Fortunately, our Ebstein symposium was scheduled for 2017. Veronika arrived in Kaliningrad at the beginning of April for her promised evaluation. She was deemed a suitable candidate for open heart surgery to repair her valve. On Thursday, April 13, surgeons Joseph Dearani (Mayo Clinic) and Vyacheslav Belov (Kaliningrad Federal Center) successfully performed the Cone reconstruction on Veronika's tricuspid valve.

She was discharged from the PCICU the day after her operation. Her prognosis is good; Veronika has a normal life expectancy. However, like any child with a severe congenital heart defect, Veronika will undergo annual evaluations by a cardiologist.

As with many of our patients, Veronika had a special impact on our team. We are thrilled that she was able to receive the life-saving surgery she desperately needed and wish her the very best in making her dream of working with computers a reality.

Patient story based on an interview conducted in Kaliningrad by Hannah Hunter with the help of an interpreter.

PATIENT PROFILE

Child	Makar K.
Date of birth	August 10, 2016
Weight	Current: 16 lbs; at birth: 8 lbs 3 oz
Home	Volgograd (1,400 miles from Kaliningrad)
Diagnosis	Ebstein, atrial septal defect (ASD)
Open heart surgery	Cone repair, narrowing of ASD April 11, 2017
Discharged from PCICU	April 12, 2017

Makar's story: an infant boy undergoes the Cone repair

Makar is a bubbly eight-month-old boy. He arrived to the Kaliningrad Federal Center with his mother Maria. They traveled from Volgograd, a city more than 1,400 miles away, where Maria works as a database administrator for an oil company.

Makar's heart condition was diagnosed before birth. Maria knew that she would have to be assertive in order to get him the care he needed. Although understandably nervous, she was thankful beyond words to be in Kaliningrad where her baby could receive timely access to specialized valve surgery.

Makar's diagnosis was confirmed by the Heart to Heart-Kaliningrad team: Ebstein anomaly and a large atrial septal defect (ASD). Because Ebstein anomaly is so rare, few surgeons in Russia are capable of performing the valve-sparing surgery required to correct this defect. Makar was fortunate that his cardiologist was able to contact physicians in Kaliningrad who arranged for a consultation with Heart to Heart specialists. Even though Makar had not yet reached his first birthday, his condition was severe enough to require immediate surgery. The anatomy of his heart looked favorable for valve repair. To confirm his candidacy for surgery, the Heart to Heart-Kaliningrad specialists performed diagnostic catheterization pre-operatively.

The day after his catheterization, Makar was scheduled for open heart surgery: a Cone reconstruction and a narrowing of his ASD. The operation was a success. He recovered quickly and was in his mother's arms the next day.

Many of Heart to Heart's medical volunteers on this mission were recruited from the Mayo Clinic, known for its expertise in the treatment of Ebstein anomaly. Because the Cone procedure is relatively new, it is not yet known what further care these children may require over the long term (as adults). However, to date, surgical outcomes look good. How well each patient feels postoperatively depends not only on the quality of the valve repair, but also on the function and strength of the right ventricle. Ebstein anomaly, while known as a valve defect, is also a defect of cardiac muscular tissue. Ebstein patients' right ventricles are often thinner and less competent than those of people without heart disease. The timing of surgical intervention for Ebstein repair depends on the function of both the tricuspid valve and the right ventricle.

The vast majority of children who have undergone the Cone reconstruction at Mayo have not required valve replacement within 10 years of their initial surgery. By all accounts, Makar's prognosis is good. He will continue to have annual check ups with his local pediatric cardiologist. We wish Makar a very happy and healthy first birthday – with many more to come!

Patient story based on an interview conducted in Kaliningrad by Hannah Hunter with the help of an interpreter.

Historic Volgograd: "Hero City"

Volgograd is located along the Volga River. Industries include: shipbuilding, oil refining, and steel making. Formerly known as Stalingrad, the city became famous for its fierce resistance during the largescale decisive Battle of Stalingrad against the German Army in World War II. In 1961, Stalingrad was renamed Volgograd during the era of the Soviet Union known as "de-Stalinization."

In 1967, a statue named, *The Motherland Calls*, was erected to commemorate the nearly two million people wounded, killed, or captured in the Battle of Stalingrad. As of 2016, the statue remains the tallest sculpture of a woman in the world.

FINANCIAL OVERVIEW

Financial support

Edwards Lifesciences Foundation	59,218
Abbott Fund	20,000
Boeing Charitable Trust	15,000
GE Russia/CIS	10,000
Alcoa Foundation	9,886
Total Financial Support	**$114,104**

In-kind support

In-kind medical services	507,641
Non-medical in-kind (see Expenses below)	22,909
Total In-kind Support	**$530,550**

Total program value

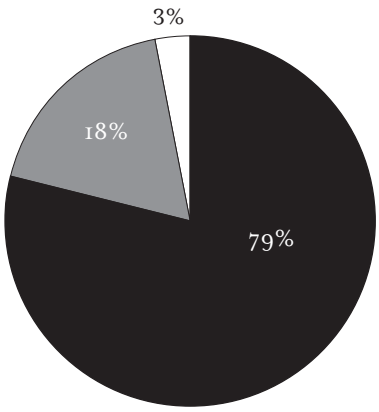
Donated medical services	507,641
Expenses (excl. non-medical in-kind)	114,104
Non-medical in-kind donations (Russian)	22,909
Total Program Value	**$644,654**

Expenses

Airfare, in-kind	8,369
Travel	24,453
Travel insurance, in-kind	720
Ground transportation, in-kind	1,100
Lodging, in-kind	9,400
Meals, in-kind	2,040
Program supplies	465
Pre- and post-trip coordination + logistics	49,052
Visas, in-kind	1,280
Year-round program development	40,134
Total Expenses	**$137,013**

Data compilation as of August 29, 2017

KALININGRAD PROGRAM YEAR 5
Total Program Value: $644,654



- Heart to Heart in-kind medical services $507,641
- Expenses (excl. non-medical in-kind) $114,104
- Non-medical in-kind donations (Russian) $22,909

PROCEDURES PERFORMED APRIL 2017

Echo studies + readings (62)	72,482
Cath lab - diagnostic (4)	32,256
Cath lab - interventional (1)	34,674
Pediatric open heart surgeries (8)	185,800
Perfusion (8)	27,600
Intraoperative TEE (8)	9,600
TEE EP studies (3)	73,326
Post-op exams /readings (10)	3,840
ICU post-op care, MD (11)	23,628
RN/tech support (ICU + OR)	17,435
Professional consulting + lectures	27,000
Total In-kind Medical Services	**$507,641**

82% of the total program value consisted of goods and services donated in-kind to Heart to Heart and utilized in Kaliningrad in Program Year 5. The remaining 18% consisted of financial support from our major sponsors.

Thank you to our major sponsors for their faith and investment in global health equity

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