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Angiotensin II Receptor Blocker Slows the Rate of Progression of Aortic Root Dilatation in Marfan Syndrome: Two Case Reports and Review of the Literature

By Huda Elshershari, MBBCh; Mosaab Esseid, MBBCh; Vithida Sueblinvong, MD; Catharine Harris, MD

Contributor's Statement

Huda Elshershari: Dr. Elshershari treated and followed the two cases, drafted the initial manuscript, and approved the final manuscript as submitted.

Mosaab Esseid: Dr. Esseid reviewed and revised the manuscript, and approved the final manuscript as submitted.

Vithida Sueblinvong: Dr. Sueblinvong treated and followed the two cases, reviewed and approved the final manuscript as submitted.

Catharine Harris: Dr. Harris carried out the initial genetic evaluation of both cases, critically reviewed the manuscript, and approved the final manuscript as submitted.

Abstract

Marfan Syndrome is a connective tissue disorder with significant cardiovascular complications such as aortic root dilatation, development of aortic aneurysm or rupture. We report two children diagnosed with Marfan Syndrome and aortic root dilatation in early childhood. Marfan Syndrome is caused by Fibrillin 1 gene mutation in both cases that was transmitted from affected parent. They were treated with Losartan which slowed the progression of aortic root enlargement.

Key Words: Marfan; Fibrillin; mutation; Losartan

Introduction

Marfan Syndrome is an autosomal dominant connective tissue disorder in which abnormalities occur in the cardiovascular, ocular and musculoskeletal systems. The majority of mutations occur in FBN1 gene located at chromosome 15q21.1.[1] However, 10% of the mutations occur in transforming growth factor-beta receptor 2 (TGFBR2) and 1 (TGFBR1) genes, respectively which result in Loeys-Dietz Syndrome (a connective tissue disorder with phenotypic overlap with Marfan Syndrome). The Fibrillin -1 is an important constituent of connective tissues, and the histopathology of aortic tissues shows fragmentation of elastic lamellae and fibrosis. The exact molecular mechanism is not understood, but one of the proposed mechanisms is increased bioavailability of transforming growth factor-beta (TGF-β). Recent research from mouse

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models of Marfan Syndrome demonstrates aortic root enlargement due to excessive signaling by TGF-β.[2]

Angiotensin II Type 1 receptor blocker, Losartan (Cozaar, Merck) is a TGF-β antagonist, therefore, it prevents progressive enlargement of the aortic root.[2, 3] We present two cases of Marfan Syndrome with aortic root dilatation that were stabilized on Losartan treatment during early childhood.

Case 1

This male infant was born to a Hispanic family and the father had presumed diagnosis of Marfan Syndrome for many years, but had never been tested. He had a past history of aortic valve replacement and multiple eye surgeries. The mother and her other two children from a previous relationship were healthy. The infant was born at term by spontaneous vaginal delivery with a birth weight of 3200 gram (25th percentile) and a length of 51 cm (>50th percentile). Physical examination revealed long and protruding ears, micrognathia, high arched palate, arachnodactyly and undescended testicles. No heart murmur was heard. Ophthalmologic examination was unremarkable.

Initial echocardiogram study at one month of age showed aortic root dilatation measured 1.60 cm (Z = 2.94). The diagnosis of neonatal Marfan Syndrome was raised because of both physical findings and cardiac abnormality. Molecular genetic studies were performed for the infant and father which revealed a mutation in exon 31 of the FBN1 gene in the infant and his father. Losartan and propranolol therapies were initiated at three months of age. His blood pressure and renal function were closely monitored.

Case 2

A three-and-a-half-year old Hispanic male was referred for evaluation by an ophthalmologist because of visual examination failure at school; he was diagnosed with bilateral ectopia lentis; Marfan Syndrome was suspected, and was referred for genetic evaluation. Physical examination revealed tall stature (>95%), large ears, high arched palate and hyper-extensible elbows. No heart murmur was noticed. Further genetic testing confirmed mutation in exon 2 of the FBN1 gene in the child that was transmitted from his affected mother. Initial echocardiography was performed at 4 years of age showed aortic sinus dilatation and measured 2.45 cm (Z=2.37). Therefore, the patient was started on Losartan and Beta-blocker.

Treatment and Clinical Course

Both patients were started on Losartan (Cozaar, Merck) at an initial oral dose of 0.6 mg per kilogram per day. They were assessed for adverse events at this starting dose over a 3-week period before the dose was gradually increased to maximum 1.4 mg per kilogram per day. Blood pressure of both patients was closely monitored during follow-up after initiation of Losartan. The renal function (blood urea nitrogen and creatinine levels) and electrolyte levels were normal at initiation of therapy and after three months. The first case was continued on Beta-blocker therapy alone at one year of age, and Losartan was discontinued because of low blood pressure; his parents could not afford Losartan therapy. The second case was continued on Angiotensin receptor blocker medication alone; Beta-blocker was discontinued after 12 month of initiation of the combined therapy due to hypotension. Serial transthoracic echocardiogram examinations were performed to measure aortic sinus of Valsalva during follow-up visits for approximately 5 years.

"We present two cases of Marfan Syndrome with aortic root dilatation that was stabilized on Losartan treatment during early childhood."

Echocardiography Findings

Maximal aortic diameter was measured at the aortic annulus, sino-tubular junction, ascending thoracic aorta and aortic root (at the sinuses of Valsalva) in the parasternal long-axis view. All measurements were performed from internal edge to internal edge of the aortic wall during ventricular systole. Body mass index was calculated from height and weight, and were converted into Z score which is normalized for age and sex. Serial echocardiogram studies during follow-up for 5 years showed aortic root sinus dilatation with Z score above 3 in the first case; significant improvement of aortic root dilatation with Z score less than one in the second case as shown in the Table.

Discussion

Marfan Syndrome is a connective tissue disorder with significant cardiovascular complications such as aortic root dilatation, development of aortic aneurysm or rupture. The neonatal Marfan Syndrome presents with a rare and severe phenotype early in childhood. A severe or neonatal Marfan phenotype can be found with mutations in exons 24-27 and 31-32, and are thought to account for 20% of FBN1 mutations. These mutations are associated with more severe phenotype including earlier presentation, higher risk of scoliosis, ectopia lentis, ascending aorta dilatation, mitral valve abnormalities, and shorter survival.[1] We report on the clinical data of two boys diagnosed with Marfan Syndrome in early childhood that was transmitted from an affected parent. The first case was diagnosed during early infancy with the neonatal form of Marfan Syndrome, and the second case presented relatively later at 3 years of age because of vision problems.

Losartan is a new therapy, and used to slow the rate of aortic root dilatation in patients

Table: Serial Aortic Sinus Diameters

Case 1			Case 2		
Age‡ (M)	Aortic Sinus (cm)	Z Score	Age‡ (Y)	Aortic Sinus (cm)	Z Score
3	1.67*	3.40	4	2.45*	2.37
6	1.77†	3.39	4.5	2.55†	2.53
9	1.86†	3.40	4 y 10 m	2.63†	2.55
17	2.10††	3.98	5.5	2.54**	1.97
24	2.12	3.53	6	2.55	1.73
36	2.26	3.09	7	2.60	0.85
48	2.39	3.53	8	2.67	0.57
60	2.43	3.57	9	2.87	0.84

‡ Age M = month; Y = year
* Before Losartan therapy
† After initiation of losartan therapy and Beta-blocker
†† Patient is taking Beta-blocker alone
** Patient is taking Losartan alone
The Z scores were calculated from aortic-root diameters normalized for age and body-surface area with the use of standard algorithms.

with Marfan Syndrome. Losartan is antihypertensive agent and TGF-β antagonist with Angiotensin II Type 1 receptor blocker effect.[2, 3] Angiotensin II acts on Angiotensin II Type 1 and Angiotensin II Type 2 receptors, respectively.[3] The functions of Angiotensin II Type 1 and 2 receptors are mutually antagonist.[4]

Molecular studies described that TGF-β is an inactive latent complex, and requires bio-activation by Thrombospondin 1.[5] Zhou et al showed in their experimental study that Angiotensin II induces TGF-β activation by increasing Thrombospondin 1. Furthermore, Angiotensin II induction of Thrombospondin 1 and increased TGF-β activity were blocked by losartan.[6] Angiotensin II Type 1 receptor signaling is shown to increase TGF-β production. Habashi et al reported that aortic aneurysm in a mouse model of Marfan Syndrome is associated with increased TGF-β signaling and can be prevented by TGF-β antagonists, the Angiotensin II Type 1 receptor blocker (Losartan). The authors concluded that β-adrenergic blockade with Propranolol diminished aortic growth rate in mice model of Marfan Syndrome, but did not prevent progressive deterioration of aortic wall architecture or aortic dilatation. Full correction of the aortic wall abnormalities in FBN1 mice model was achieved by Losartan via AT1 blockade effect.[7] Angiotensin II Type 1 receptor blocker (losartan) decreases TGF-β signaling, thus decreasing plasma TGF-β levels and over activation of Angiotensin II Type 2 receptor pathway.

Brooke et al. showed in a cohort study of 18 pediatric patients with Marfan Syndrome that Losartan slows the rate of progression of aortic root dilatation as compared to Beta-blocker alone.[8] A recent controlled trial on pediatric population comprised of 28 patients with Marfan Syndrome (Mean age 13 ± 6 years), 15 patients were randomized to receive Beta-blocker and Losartan, 13 patients received Beta-blocker alone. This study demonstrated that Losartan therapy is safe and more effective in slowing the progression of aortic root dilatation as compared to Beta-blocker therapy alone.[9] In another cohort study, twenty patients with Marfan Syndrome (aged 1.7 to 21.6 years) were enrolled in a prospective treatment study of Losartan for evaluation of the aortic dimensions.[10] The mean follow-up period was 33 ± 11 months. A significant reduction in the normalized aortic dimensions was observed with a better response to therapy when started at an earlier age and with a longer therapy duration.

Our observational study in two patients with Marfan Syndrome showed that Angiotensin II receptor blockers (Losartan) are beneficial in slowing the rate of progression of aortic root dilatation. Losartan therapy is more effective in slowing the progression of aortic root dilatation as demonstrated in the second case, compared to Beta-blocker therapy alone in the first case. Furthermore, our patients received the treatment at a younger age without any side effects. A double-blind, multicenter trial has been announced and will add to the knowledge of AT1-receptor blocker effects on aortic root dilatation in children with Marfan Syndrome.[11]

Conclusion

Losartan is currently in widespread clinical use for treatment of hypertension in both adults and children. Losartan is a TGF-β antagonist with Angiotensin II Type 1 receptor blocker effect which is a new therapy for stabilizing aortic root dilatation in Marfan Syndrome. This medication significantly slowed the progression of aortic enlargement in our patient without any side effects.

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Conflict of Interest: None of the authors have any conflict of interest about the manuscript.

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PDA Closure in a Very Low-Weight Premature Infant with ADO II Device

By Jesús María Damsky Barbosa, MD; J. Alonso, MD; A. de Dios, MD

Introduction

Endovascular closure of Patent Ductus Arteriosus (PDA) is a procedure of choice.[1] More and more centers have started closing PDA in patients under 8 kg; PDA with substantial diameters are capable of producing severe heart failure and high morbidity in these patients. This situation is worse in prematures where PDA is of considerable diameters, large and tubular.[2]

Gregory Moore et al[3] suggest that PDA ligation is associated with an extended duration of mechanical ventilation and longer hospital stays in survivors, although mortality decreased over time.

The United Kingdom Surgical Central Cardiac Audit Database of children weighing <2.5 kg and undergoing surgery, demonstrates that ligation of the arterial conduits has an 8% mortality at 30 days for this group of patients, claiming that mortality would be associated with co-morbidities rather than with the surgical technique[4] and proposes to avoid thoracotomy as a co-morbidity factor.

Since April 2011, our group developed a PDA closure protocol[5] with the aim of reducing morbidity and which could be used in patients weighing <3 kg. PDA closure is achieved only by venous puncture, without arterial puncture and under strict echocardiography control. Thus, both the use of contrast and the fluoroscopy time were reduced, and potential arterial lesions, resulting from arterial puncture, were avoided.

After experience with 16 cases using this protocol in different ages and weights, we decided to start closing PDA in patients weighing <3 kg.

Case Report

A 26 week gestation preterm male patient with 15 days of chronological age, weighing 1,040 gr., required mechanical ventilation due to pulmonary edema and decompensate heart failure.

Transthoracic echocardiography showed the existence of a PDA with left chambers dilatation and moderate mitral valve regurgitation. Medical treatment with Indomethacin was soon started: two series were performed without favorable response, with persisting mitral valve regurgitation and significant left chambers dilatation. We proposed endovascular PDA closure.

In the cath lab, right femoral vein puncture was performed guided by echocardiography. The PDA was catheterized using a right coronary catheter 4 Fr, with the help of a Terumo 0.035" guide. Lateral view (see Figure 1) and right anterior oblique angiographies were executed.

PDA had the same diameter throughout the extension of 3.9 mm and 10 mm length.

We proceeded to occlude the PDA with an II 4-5 Amplatzer device (see Figure 2).

Transthoracic echocardiography control was then performed which ruled out left pulmonary artery stenosis or residual aortic coarctation (see Figure 3).

The total amount of nonionic contrast agent used was 6 cc, and the overall fluoroscopy time 7 minutes.

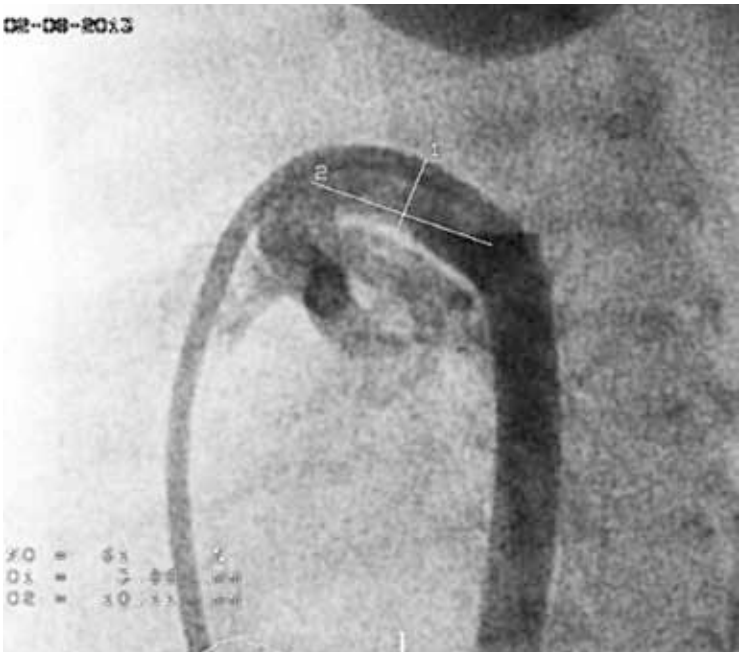


Figure 1. Lateral view: shows PDA and its measurements.

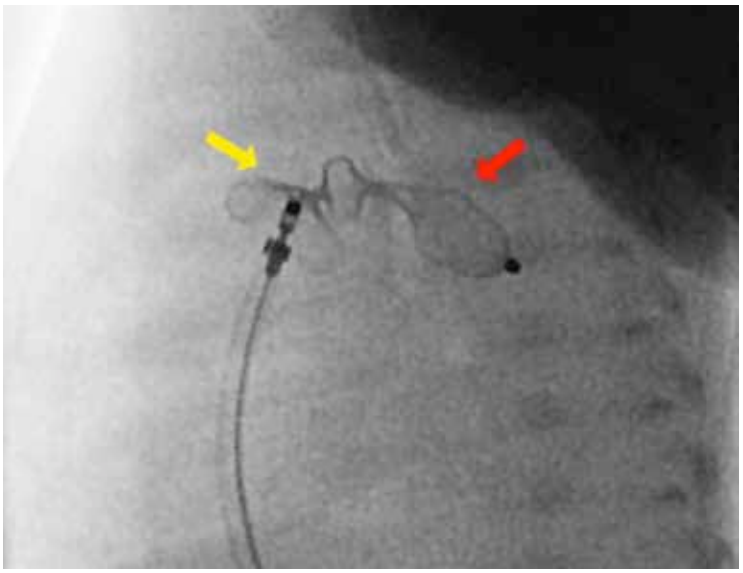
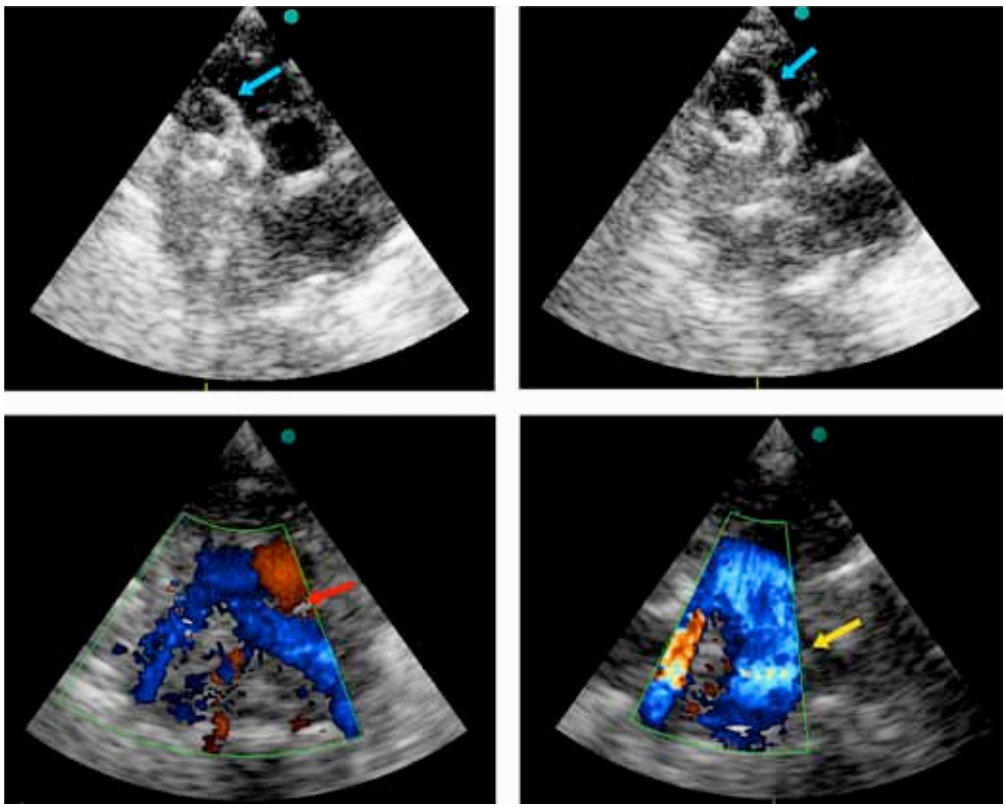


Figure 2. Lateral view: half-open left disk (red arrow) within the PDA and the right one (yellow arrow) absolutely unfolded in pulmonary artery.

Discussion

Endovascular PDA closure in very low-weight premature patients is a developing procedure. All of these patients are usually critical, under mechanical ventilation, hemodynamically decompensate, and, in general, had a previous medical treatment without favorable response. An Endovascular procedure is recommended to reduce postoperative morbidity.

To carry out this procedure,[5] it is required to know PDA's anatomy by transthoracic echocardiography, allowing us to decide which is the correct prosthesis for each case.[6] Arterial puncture should be avoided; accessing only by venous puncture reduces the use of contrast and decreases the fluoroscopy time to the most.



Picture 3: Shows the device correctly positioned in the right PDA (blue arrow) and absence of residual gradient in the left pulmonary artery (red arrow) and descending aorta (yellow arrow) from suprasternal view.

Different prostheses have been used to close PDA in premature infants: from coils[7] to[8] Amplatzer devices. In this case, we decided to use ADO II instead of ADO II AS, as recommended by Neil Wilson,[6] due to the disparate relation between the 3.9 mm diameter PDA and the 5 mm diameter Amplatzer, which caused concern about the possibility of embolization. This one being a large PDA, we decided to place an ADO II 5-4 (5 mm central body and 4 mm length with an 11 mm disk). The left disk was half-open in the PDA and the right one entirely open in the pulmonary artery without generating gradient on the left branch nor descending aorta. The result was excellent.

In the future, we hope to see the procedure carried out in the incubator, as Neil Wilson proposes.

This was the "first experience in Argentina."

Conclusion

- PDA closure was successfully achieved in a very low-weight premature infant.
- The procedure was done by venous vascular access.
- TTE helped in assessing the correct position of the device and ruled out residual aortic coarctation and left pulmonary stenosis.

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Medical News, Products & Information

Edwards' SAPIEN XT Valve Approved in Europe for Transcatheter Mitral and Aortic Valve-in-Valve Procedures

(Marketwired) - Edwards Lifesciences Corporation, a global leader in the science of heart valves and hemodynamic monitoring, announced in February it has received CE Mark in Europe for valve-in-valve procedures using the SAPIEN XT transcatheter heart valve, providing a minimally invasive treatment option for patients whose surgical mitral or aortic valves require replacement, and who are at extreme risk for surgery. Edwards is the only company to receive a valve-in-valve indication for the mitral position, which addresses an unmet need within the clinical community to provide an alternative to a high-risk surgery.

"The European approval of the SAPIEN XT system for valve-in-valve procedures is a milestone achievement. While this is not a large financial opportunity, it represents an important benefit for patients unable to go through a second open-heart surgery to replace their failing bioprosthetic valves," said Larry L. Wood, Edwards' Corporate Vice President, transcatheter heart valves.

More than 300,000 valve replacements are performed worldwide each year through open-heart surgery, utilizing either bioprosthetic tissue valves or mechanical valves. Edwards' proven family of PERIMOUNT bovine pericardial tissue valves have been the world's most frequently implanted valves for more than 30 years, which surgeons have increasingly chosen over mechanical valves, even in younger patients. Patients who receive Edwards' bovine pericardial valves are generally not required to be on lifelong anticoagulation therapy (blood thinners), as they would if they had received a mechanical valve. Decades of clinical experience and peer-reviewed data on Edwards' valves provide robust evidence of long-term performance and optimal hemodynamics of the PERIMOUNT valve platform.

"Just as native heart valves experience wear over time, bioprosthetic valves eventually degenerate, too, creating a need for a replacement valve," said Olaf Wendler, MD, PhD, Professor of Cardiac Surgery, King's College Hospital in London, and one of the principal investigators of the SOURCE XT Registry. "The European adoption of valve-in-valve procedures using SAPIEN XT is an important development for treating patients who may otherwise go untreated. In particular, patients needing a re-operation to address a failing mitral valve face a very challenging surgery, and the ability to offer a transcatheter replacement is extremely important for this patient group." Dr. Wendler provides paid consulting services to Edwards for education, and research and development of transcatheter valve technologies.

In the U.S., the SAPIEN XT valve is not commercially available; it is an investigational device being studied as part of the randomized, pivotal PARTNER II Trial. For more information visit www.edwards.com.

Study Examines Effectiveness, Safety of Transcatheter Aortic Valve Replacement in US

Michael J. Mack, MD, of the Baylor Health Care System, Plano, Texas, and colleagues describe the experience in the U.S. with Transcatheter Aortic Valve Replacement (TAVR), including patient selection, procedural details, and in-hospital and 30-day outcomes following TAVR, a less invasive procedure than open heart-valve surgery for replacing the aortic valve in the heart.

In November 2011, the U.S. Food and Drug Administration (FDA) approved use of a valve that could be implanted using a catheter for TAVR for the treatment of severe, symptomatic aortic stenosis in patients with inoperable status. The label for the valve was expanded in September 2012 to include patients at "high-risk, but operable" status. Since commercial approval, this first-to-U.S.-market TAVR device has been introduced to nearly 250 U.S. clinical sites. "Although the [initial] trials demonstrated efficacy of TAVR within a select cohort of patients and hospital centers, there are no data on dissemination and utilization patterns of this technology in routine clinical practice in the United States. Additionally, concerns persist regarding the safety and effectiveness of this novel technology as it moves beyond protocolized trial care and highly experienced centers and operators," according to background information in the study.

For this study, the researchers gathered results from all eligible U.S. TAVR cases (n = 7,710) from 224 participating registry hospitals following the device commercialization (November 2011 - May 2013). Successful device implantation occurred in 7,069 patients (92%). In-hospital mortality was 5.5%. Other major complications included stroke (2.0%), dialysis-dependent renal failure (1.9%), and major vascular injury (6.4%).

Median hospital stay was 6 days, with 4,613 patients (63%) discharged home. Among patients with available follow-up at 30 days (n = 3,133), mortality was 7.6% (noncardiovascular cause, 52%); stroke occurred in 2.8%, and new dialysis in 2.5%.

"This analysis represents the first public report from the U.S. national Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy Registry, and documents two major findings. First, post-approval commercial introduction of this new technology with an early-generation device has yielded success rates and complication patterns that are similar to those documented in carefully performed randomized trials. Second, the outcomes of procedures even with this early-generation approved device are similar to the global experience of TAVR, which now is based on second- and third-generation improved devices. These findings help address a lingering question of clinical outcomes with the first-generation TAVR device after controlled U.S. dissemination to a relatively narrow group of treatment centers," the authors write. "Longer-term follow-up is essential to assess continued safety and efficacy as well as patient health status."

New Study Reports on the High Cost of Cardiac Surgery Healthcare Associated infections

Findings reported at *AHA Scientific Sessions 2013* reveal the economic impact of HAIs following cardiac surgery.

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The study author is Giampaolo Greco, PhD, Assistant Professor of Health Evidence and Policy at Icahn School of Medicine at Mount Sinai.

After cardiac surgery, healthcare-associated infections (HAIs) are common complications associated with increased morbidity, mortality, and use of resources.

Study findings reported at the *American Heart Association's Scientific Sessions 2013* by investigators from the Cardiothoracic Surgical Trials Network (CTSN), whose Data and Clinical Coordinating Center is at Icahn School of Medicine at Mount Sinai, revealed the substantial economic impact of HAIs following cardiac surgery and the importance of preventing these infections leading to re-hospitalizations.

In the new analysis, researchers examined data about the incremental costs associated with major HAIs within 65 days of cardiac surgery. Clinical data from 4,320 patients at nine academic medical centers was merged with related financial data routinely collected by the University Health Consortium in the United States. The most common cardiac surgery procedures incurred by these patients included valve surgery, coronary artery bypass graft (CABG), and CABG/valve surgery.

The data show during hospitalization, 2.7% of patients experienced major infections, such as pneumonia, sepsis, C. Difficile, and surgical site infections.

The average cost due to treating major HAI infection was calculated as about $40,000, with increased costs from Intensive Care Unit stays being an important contributing factor. Also, patients with major HAIs were nearly twice as likely to be readmitted as those with non-HAIs. In the patient population studied, there were 74 readmissions, with 8.7% due to HAIs.

"Our analysis found readmissions due to HAIs, after cardiac surgery cost on average nearly three times as much as non-HAI related readmissions," says Giampaolo Greco, PhD, Assistant Professor of Health Evidence and Policy at Icahn School of Medicine at Mount Sinai.

"We need to take action to avert preventable readmissions due to HAI infection rates after cardiac surgery, first for the patient's health and also to curb rising healthcare costs," says Dr. Greco.

This study was funded by the National Institutes of Health and Institute for Health Technology Studies (InHealth), a non-profit foundation.

As principal investigator for CTSN's Data and Clinical Coordinating Center based at Mount Sinai, Annetine C. Gelijns, PhD, Professor and Chair of the Department of Health Evidence and Policy at Icahn School of Medicine at Mount Sinai, previously received financial compensation as a consultant for InHealth's Research Council, which has supported some of the study-related analyses.

This study was presented at the *AHA Scientific Sessions 2013* in Abstract Poster Session (18267): The Economic Impact of Healthcare Associated Infections in Cardiac Surgery.

For more information, go to: www.mountsinai.org.

Heart Pump with Behind-the-Ear Power Connector: One-Third of Heart Failure Patients with Heart Pumps Develop Infection at Abdominal Power Connection Site

Newswise - Cardiac surgeons and cardiologists at the University of Maryland Heart Center are part of a multi-center clinical trial evaluating the efficacy of powering heart pumps through a skull-based connector behind the ear. Typically, these devices for patients with severe heart failure are energized through an electrical cord connected at an abdominal site, where potentially deadly infections can develop.

"Over time, nearly one-third of our patients surviving with the assistance of an implanted blood pump develop an infection at the site where the power cord exits the skin. This complication may be lethal but, if not, it is always a difficult problem," says the University of Maryland's principal investigator, Bartley P. Griffith, MD, The Thomas E. and Alice Marie Hales Distinguished Professor of Surgery at the University of Maryland School of Medicine, and a senior cardiac surgeon at the University of Maryland Medical Center.

The infection-prone abdominal connection also limits some activities such as swimming and bathing, since water may also contribute to infection.

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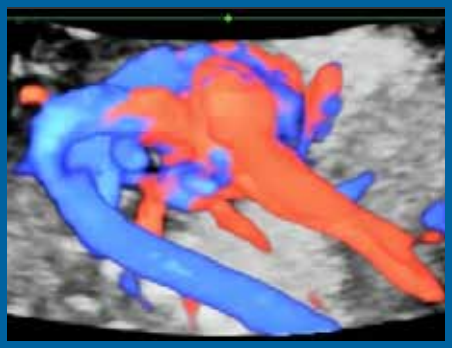

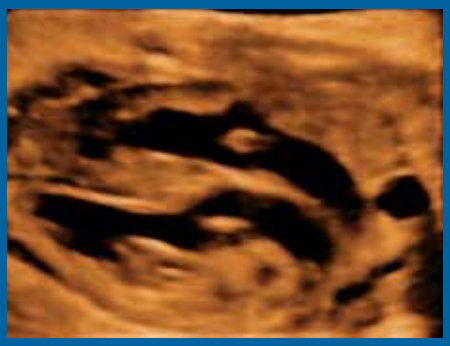

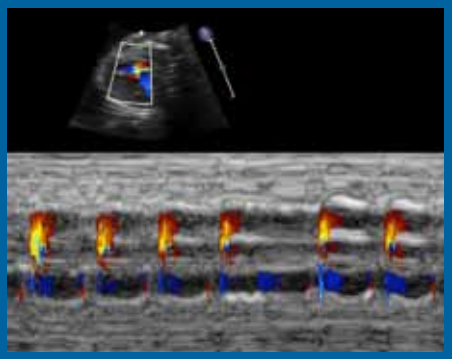

This conference offers the unparalleled exposure to national and international experts, creating an authoritative learning venue with an incredibly comprehensive and intensive program on fetal cardiology and fetal cardiology imaging. Lectures, procedure demonstrations and interactive case study formats will focus on expanding evidence-based care management strategies for clinical decision making.

This four-and-a-half day conference will:

- discuss important concepts in congenital heart disease as well as the most recent advances in imaging, diagnosis and management of fetal cardiac abnormalities.
- have added emphasis on the perinatal and genetics components, with advanced techniques in the assessment of the fetal circulation and extracardiac abnormalities
- have breakout workshops including 4D echo volume manipulation, hands on scanning, and Doppler assessment techniques are planned
- provide an opportunity for abstract submissions and poster presentations

Confirmed Guest Faculty Include:

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Mary Donofrio, MD
Lisa Hornberger, MD
James Huhta, MD
Edgar Jaeggi, MD
Giancarlo Mari, MD
Anita Moon-Grady, MD
Jack Rychik, MD
Norman Silverman, MD
Wayne Tworetzky, MD

This symposium has been designed for physicians- both pediatric cardiology and maternal fetal medicine, sonographers and other paramedical colleagues. For more information regarding CME, please call (602) 933-0766.

For more information, email Kathryn Poole at kpoole@phoenixchildrens.com

The pumps, called Left Ventricular Assist Devices (LVADs), support the heart's main pumping chamber, the left ventricle. LVADs are implanted in the chest and powered with external batteries.

The study, named RELIVE (Randomized Evaluation of Long-term Intraventricular VAD Effectiveness), compares two similar continuous flow heart pumps designed for "destination therapy." The devices provide long-term support to patients with end-stage heart failure who, for a variety of reasons at the time of implant, are ineligible for a heart transplant. The major difference is in the way electrical power from the battery pack gets to each pump implanted in the chest. In one case, the internal power cord is routed through a traditional opening, or pump pocket, in the abdominal wall. In the other, the internal power cable is tunneled through the neck to the head. The internal cable is connected to a socket or pedestal placed behind the ear in the skull, in the same area used to pass cochlear implant electrode wires into the body. On the outside of the skull, a waterproof cable running from the battery pack is plugged into the socket.

Patients in the study are randomly assigned to one of two groups. The treatment group receives a Jarvik 2000 LVAD equipped with an investigational "post-auricular" connector from Jarvik Heart, Inc., the funder of the study. Control group patients are given a heart pump that employs an abdominal connector, Thoratec Corporation's HeartMate II Left Ventricular Assist System, which is the most widely used FDA-approved LVAD for destination therapy.

Part of the problem with the abdominal approach is related to the softness and flexibility of the abdomen. According to Dr. Griffith, tiny, micro-movements of the power cable at the abdominal entrance are all it takes to set the stage for infection. The investigators theorize that the stability of the bone-mounted terminal coupled with the vast blood supply in the scalp will reduce the chance of infection. "The bone in the skull is a better substrate to locate a foreign body on, because there's good blood flow, and there's no motion," says Dr. Griffith. At the same time, the investigators posit that the location of the connector in the head should provide quality of life benefits for patients who would otherwise not be able to take a shower or swim.

The cardiac team at the University of Maryland Heart Center has years of

experience with both the HeartMate II and another version of the Jarvik 2000 with an abdominal pump pocket. Two other cardiac surgeons at the University of Maryland Medical Center are participating in the study: Keshava Rajagopal, MD, PhD, Assistant Professor of Surgery at the University of Maryland School of Medicine, and Si M. Pham, MD, Professor and Director of the Heart, Lung Transplant and Thoracic Mechanical Assist Devices Program at the University of Maryland School of Medicine. A cardiologist on the team, Erika D. Feller, MD, Assistant Professor at the University of Maryland School of Medicine and Medical Director of Heart Transplantation and Ventricular Assist Devices at the University of Maryland Medical Center, provides continuing cardiac care and monitoring of patients in the study.

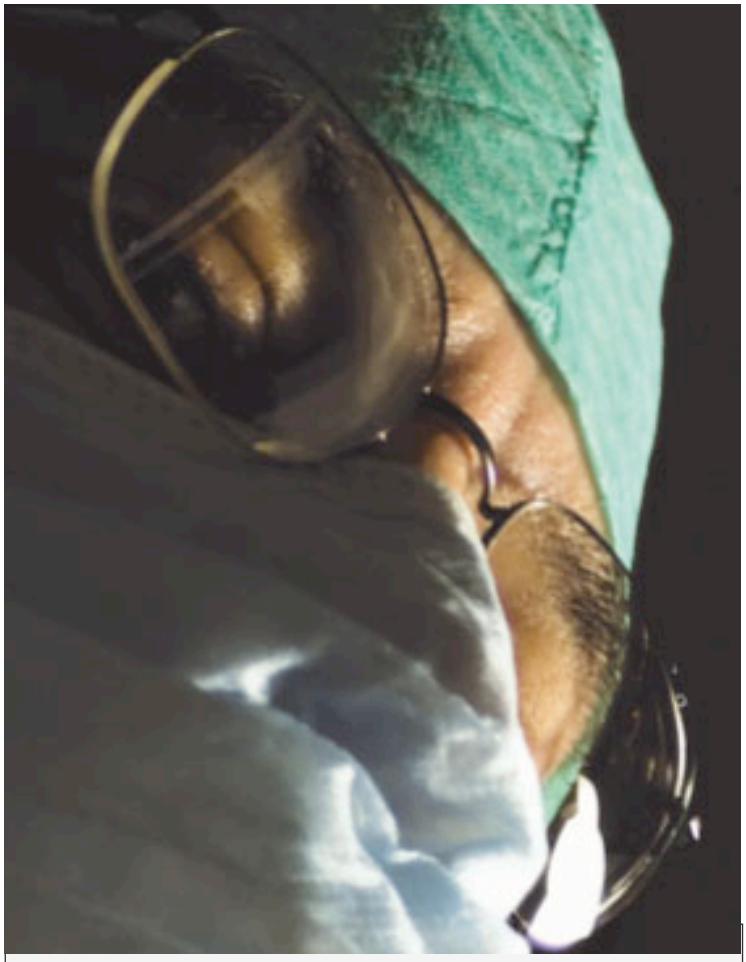
Since the Jarvik implantation involves the head and neck, the cardiac team has formed an unusual collaboration with another surgical department at the School of Medicine. Ronna P. Hertzano, MD, PhD, Assistant Professor of Otorhinolaryngology-Head and Neck Surgery at the University of Maryland School of Medicine, extends the internal Jarvik power cord through the neck and places the socket in the skull. Dr. Hertzano, whose specialty includes hearing restoration and diseases of the ear and lateral skull base, works alongside the cardiac surgical team at the time of the procedure to correctly place the wire and skull connector.

"Cardiovascular disease kills one in three Americans. Particularly desperate is the plight of severely ill heart failure patients who have few options. The shortage of donor hearts for transplant has increased the need for functional and safe heart pump technology that not only keeps patients alive, but also extends the quality of their lives," says E. Albert Reece, MD, PhD, MBA, VP for Medical Affairs at the University of Maryland and the John Z. and Akiko K. Bowers Distinguished Professor and Dean of the University of Maryland School of Medicine. "It is gratifying to see that School of Medicine faculty surgeons and cardiologists are at the forefront of research efforts that may accomplish both goals. This research is part of our overall strategy to extend the best of care to our cardiac patients while also exploring more effective ways to prevent heart disease in the first place."

Infection was less of an issue in the early days of heart pump technology due to the limited durability of the devices, according to Dr. Rajagopal. "Device failure and many other problems associated with the early pumps, such as bleeding and clotting, limited patient survival. Infection was comparatively low on the list of concerns, but with more durable ventricular assist device therapies, infection is much more important than it was previously."

Early LVADs tried to mimic the normal heartbeat and its pulsating blood flow, circulating blood with a series of mechanical valves. They produced a pulse, but were prone to wear out quickly, and were used as a "bridge to transplant," a short-term life-saver until a donor heart could be found. Today, improved pump designs that produce continuous, minimally pulsatile blood flow make it possible for LVADs to run for years. Extended pump life, in turn, has been responsible for durable destination therapy, in which the device supports the patient for the remainder of his or her life.

The Jarvik skull model has already been approved for use in Europe. The clinical comparison study in the United States opened for



patients this year. The University of Maryland enrolled the second patient in the U.S. to receive the Jarvik pump with the skull-based connector. The study will follow 350 patients for up to three years.

International Children's Heart Fund (ICHF) Looking for Volunteer Pediatric Interventionalists for Babyheart Missions in 2014

ICHF has conducted medical mission trips since the beginning of their work in 1993. Their trips have increased over the years so that now there are at least two ICHF Medical Teams every month repairing children's hearts somewhere in the world. The year 2013 represented their most ambitious schedule to-date. There are more trips on the schedule for 2014.

If you have what it takes to volunteer for a Babyheart Mission, contact Jean Towne, Medical Team Coordinator at jean.towne@babyheart.org.

The Mission Trip May-December 2014 Schedule is as follows:

- May 3 -17: Tegucigalpa, Honduras
- May 17 - 31: Kharkiv, Ukraine
- May 17 - 31: Guayaquil, Ecuador
- May 24 - Jun. 7: Jimani, Dominican Republic
- May 31 - Jun. 28: Benghazi, Libya Program
- May 31 - Jun. 14: Santiago, Dominican Republic
- May 31 - Jun. 14: Skopje, Macedonia
- Jun. 14-28: Kharkiv, Ukraine
- Jul. 12 - 26: Guayaquil, Ecuador
- Jul. 26 - Aug. 9: Santiago, DR
- Aug. 9 - 23: Enugu, Nigeria
- Sep. 6 - 20: Tegucigalpa, Honduras
- Sep. 6 - 20: Guayaquil, Ecuador
- Sep. 6 - 20: Kharkiv, Ukraine
- Sep. 13 - 27: Skopje, Macedonia
- Sep. 27 - October 11: Voronezh, Russia
- Oct. 25 - Nov. 8: Guayaquil, Ecuador
- Nov. 8 - 22: Tegucigalpa, Honduras
- Nov. 8 - 22: Santiago, Dominican Republic
- Nov. 8 - 22: Bishkek, Kyrgyzstan
- Nov. 22 - Dec. 6: Mirebalais, Haiti
- Dec. 6 - 20: Skopje, Macedonia
- December 6 - 20: Guayaquil, Ecuador

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