

CONGENITAL CARDIOLOGY TODAY

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Pulmonary Hypertensive Crises in the Pediatric Cardiac Intensive Care Unit: Breaking the Vicious Cycle

By Avihu Z. Gazit, MD; Paul A. Checchia, MD, FCCM; and Phineas P. Oren, MD

Short title: pulmonary hypertensive crises in pediatrics

Keywords: pulmonary vascular resistance, coronary driving pressure, intensive care unit

Abstract

A 6-month old infant with large ventricular septal defect and DiGeorge Syndrome is admitted to the pediatric cardiac intensive care unit with respiratory failure due to human metapneumovirus infection. His course is complicated by multiple life threatening episodes of pulmonary hypertensive crises. We use this child's case to discuss the pathophysiology, prevention and management of pulmonary hypertensive crisis in critically ill children of all ages.

Introduction

One of the major challenges of the pediatric cardiac intensivist is management of pulmonary hypertension and pulmonary hypertensive crisis (PHC). Recognizing children at risk and understanding the pathophysiology of PHC is vital for prevention and management should it occur.

Patient presentation

Case presentation: A 6-month-old infant with DiGeorge Syndrome and large muscular outlet

“One of the major challenges of the pediatric cardiac intensivist is management of pulmonary hypertension and pulmonary hypertensive crisis (PHC).”

ventricular septal defect (VSD) is emergently admitted to the pediatric cardiac intensive care unit (CICU) with severe respiratory distress and hypoxemia. On physical examination his oxygen saturation (on 2L/min oxygen per nasal cannula) is 80%, and his respiratory rate is 60/min. His blood pressure is 90/50 mmHg, and his heart rate is 160/min. He is irritable and dyspneic. He has severe suprasternal, intercostal, and subcostal retractions, diminished breath sounds bilaterally, and bilateral inspiratory and expiratory wheezing. Chest radiograph reveals bilateral perihilar interstitial opacities and right upper lobe consolidation. His nasopharyngeal viral culture is positive for human metapneumovirus. He suffers a cardiorespiratory arrest during orotracheal intubation and is resuscitated successfully. During his hospitalization he has multiple episodes of desaturation, bradycardia, and elevation of central venous pressure precipitated

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by coughing and endotracheal tube suctioning. These episodes are consistent with PHC.

Discussion

The most malignant manifestation of increased pulmonary vasoreactivity in children with congenital heart disease is the PHC. This can be defined as the pulmonary arterial pressures reaching systemic or suprasystemic levels. At risk are children with underlying increased pulmonary artery pressure and flow, elevated pulmonary vascular resistance (PVR) associated with obstruction to pulmonary venous drainage, or elevated left ventricular end-diastolic pressure. The risk increases after cardiopulmonary bypass and with pulmonary infections. Risk stratification is based on the child's age and type of cardiac pathophysiology.

The Neonate

PVR remains relatively elevated and labile during the first few days of life (Figure 1). Therefore, repair or palliation of complex congenital heart disease, such as transposition of the great arteries, Hypoplastic Left Heart Syndrome, and pulmonary atresia with intact ventricular septum, is usually avoided during this time frame. Neonates with transposition of the great arteries and Hypoplastic Left Heart Syndrome with an intact or restrictive atrial septum may have severe and persistent pulmonary hypertension and may require emergent atrial septostomy in order to improve the physiological shunt and decompress the pulmonary veins. These neonates, as well as newborns undergoing emergent palliation of total anomalous pulmonary venous connection with obstruction, remain at high risk for persistent pulmonary hypertension and PHC; although that risk is not beyond the early neonatal period¹.

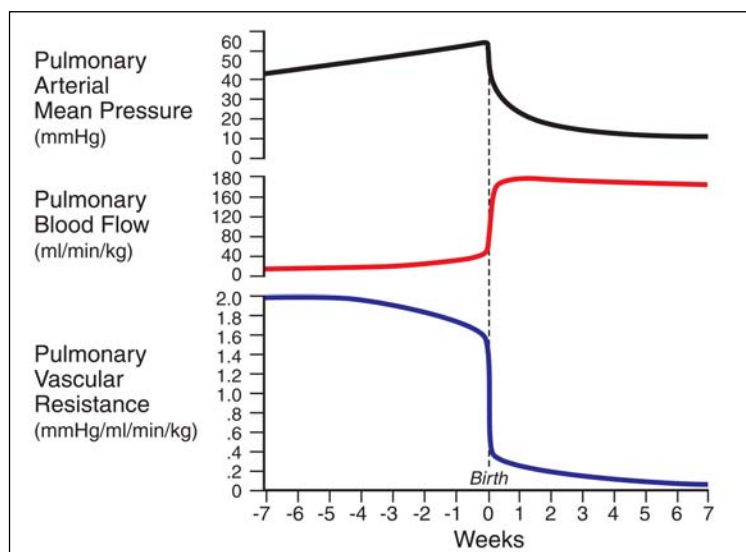


Figure 1.

The Infant

Increased pulmonary blood flow due to a VSD or complete atrioventricular canal defect places children at risk for postoperative pulmonary hypertension and PHC although that risk is not high if the

operation is performed within the first 6 months of life. Delaying the repair beyond this time frame increases the risk for postoperative pulmonary hypertension due to pathologic pulmonary vascular changes. Late diagnosis and repair of more complex congenital heart disease such as transposition of the great arteries with VSD and truncus arteriosus places infants at risk for pulmonary vascular obstructive disease within the first few months of life².

The Older Child

Elevation of PVR is common in pediatric patients with end-stage cardiomyopathy^{3,4}. Patients with dilated or restrictive cardiomyopathy and pulmonary hypertension who present with decompensated heart failure are at extreme risk for hemodynamic compromise during any intervention. PHC in the face of global myocardial dysfunction may be fatal and must be prevented⁵. Understanding the pathophysiology of PHC is required to anticipate the consequences of acute interventions among which the most challenging is tracheal intubation.

Pathophysiology

PHC is caused by an acute increase in PVR leading to acute right ventricular (RV) hypertension. RV hypertension decreases coronary driving pressure defined as the difference between the mean aortic and mean RV pressures⁶. The resultant decrease in RV coronary blood flow in the face of increased myocardial oxygen demand leads to RV myocardial ischemia and consequent pump failure ultimately leading to cardiogenic shock (Figure 2). This mechanism was demonstrated by Vlahakes and colleagues who used an acute animal model with fixed pulmonary artery obstruction⁷. This model employed a water-filled pulmonary artery occluder. Pulmonary artery occlusion was incrementally increased until RV failure occurred. RV failure was defined by changes in systemic and RV pressures that continued to progress without further increments in pulmonary artery occlusion. RV function improved by increasing the RV coronary driving pressure with phenylephrine while RV afterload remained fixed.

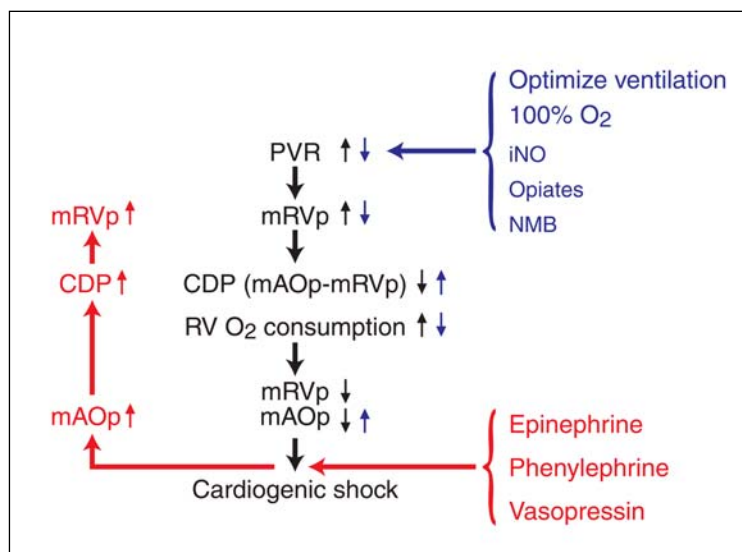
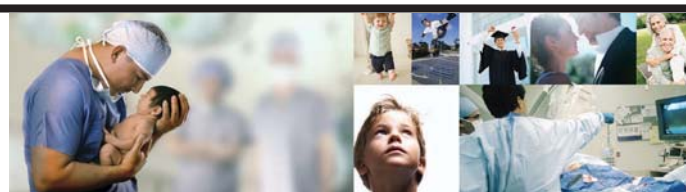


Figure 2.



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Prevention of Pulmonary Hypertensive Crisis.

Tracheal Intubation

Intubation of a sick child with pulmonary hypertension is an extremely high risk procedure that might trigger a PHC. Hence, it should be performed by an experienced operator in an intensive care unit. The team should be fully prepared for cardiopulmonary arrest, as is exemplified by our earlier case presentation. Hypotension must be avoided since it will lower the RV coronary driving pressure leading to PHC. Intravenous administration of epinephrine (0.01 mg/kg) prior to induction medications should therefore be considered. Atropine or glycopyrrolate is administered in order to ablate the vagal response associated with laryngoscopy and intubation. Fentanyl is used because of its minimal cardiovascular effects as well as its rapid onset of action. We use rocuronium rather than succinylcholine since the latter can be associated with severe adverse drug reactions such as malignant hyperthermia, bradycardia, and hyperkalemia. At the upper dose ranges it is an acceptable substitute for succinylcholine for rapid sequence induction (1-1.2 mg/kg). Its cardiovascular effects are minimal and may include increase in heart rate associated with pain on injection and mild vagolytic effect. Even with optimal peri-intubation management, cardiopulmonary arrest may occur. Acute cannulation for extracorporeal membranous oxygenator (ECMO) support should be anticipated and prepared for.

Mechanical Ventilation

Ventilator mode and settings are chosen to optimize RV preload and afterload taking into account lung volume-dependent changes in PVR and cardio-pulmonary interactions secondary to lung volume. Overall, the key concept is to maintain the lungs at functional residual capacity in order to avoid alveolar capillary compression and decreased systemic venous return due to overinflation, or hypoxic pulmonary vasoconstriction due to underinflation and hypoventilation. The ventilation mode used in our CICU is pressure-controlled rather than flow-controlled. Pressure-controlled ventilation delivered with a decelerating flow waveform applies the greatest cumulative pressure to the respiratory system. Stretching forces applied to the alveolus are also maximally sustained⁸.

Inhaled Nitric Oxide

Inhaled nitric oxide (iNO), a selective short-acting pulmonary vasodilator with minimal adverse hemodynamic effects may be used in conjunction with mechanical ventilation. Recent studies suggest that iNO at concentrations of 5-40 ppm is effective at reducing PVR as well as preventing postoperative PHC when used after repair of CHD^{9,10}. Weaning iNO should be slow in order to avoid rebound pulmonary hypertension¹¹. Sildenafil, a phosphodiesterase-5 inhibitor should be considered as a long-term medication and can be used to facilitate iNO discontinuation if necessary¹².

Sedation

Adequate sedation and analgesia is required during mechanical ventilation to prevent PHC triggered by agitation, pain, or endotracheal tube (ETT) suctioning. The medications used to achieve these effects should have an adequate cardiovascular safety profile. Fentanyl and midazolam were routinely used in our institution. However, our approach changed with the recent introduction of dexmedetomidine that exerts its physiologic effects via central α_2 adrenergic receptors. Its mechanism of action involves postsynaptic activation of these receptors in the central nervous system leading to decreased norepinephrine turnover and decreased central sympathetic outflow from the medullary vasomotor center with sympatholysis, decreased heart rate and blood pressure, and subsequent augmentation in the activity of inhibitory neurons, including γ -aminobutyric acid. This results in a sleep-like state, sedation and anxiolysis¹³. A randomized trial comparing the efficacy and safety of prolonged sedation with dexmedetomidine versus midazolam for mechanically ventilated patients noted superior sedation and

hemodynamic profile in the patients treated with dexmedetomidine¹⁴. A recent study by Lazol, et al¹⁵ suggests that dexmedetomidine may be associated with decreased pulmonary artery pressure in children after CHD operations. PHC triggered by ETT suctioning may be prevented by pre-suctioning administration of fentanyl (usually 1 mcg/kg) as well as ETT administration of lidocaine 0.25% (1 mg/kg).

Monitoring

Cardiovascular and respiratory monitoring is required to assess systemic perfusion. Standard invasive cardiovascular monitoring includes arterial, central venous, and atrial pressures. The use of the pulmonary artery catheter in pediatric patients is limited and controversial but may be useful in select patients with pulmonary hypertension. A recent addition to the invasive cardiovascular monitoring arsenal is the Pulse Contour Analysis and Continuous Cardiac Output (PiCCO) system (Pulsion Medical Systems, Munich, Germany). The PiCCO measures cardiac output (CO) by transpulmonary thermodilution and superimposes that measurement on the arterial wave form to allow for continuous CO measurement, however it is not reliable in face of a significant intracardiac shunt. A high correlation was found between the transpulmonary CO measurements and calculations based on the Fick principle in children^{16,17}. An indirect measurement of systemic perfusion by near-infrared spectroscopy (NIRS) is widely used in the CICU setting nowadays. Unlike pulse oximetry, which focuses on pulsatile flow, the NIRS regional tissue oxyhemoglobin saturation is a venous-weighted value¹⁸ and serves as a surrogate for central venous saturation. To complete the picture, arterial lactate and central venous saturations are measured. These biochemical markers track 2 different physiological responses to low CO state and were found to have predictive power for major events after CHD operations¹⁹.

Management of PHC in the Mechanically Ventilated Child (Figure 2).

Prompt recognition and treatment are mandatory. Acute increase in PVR leads to RV hypertension, low RV coronary driving pressure and cardiogenic shock. Clinical signs of shock are evident. Monitoring devices show bradycardia, hypotension, and elevated atrial pressures. NIRS saturations and transpulmonary CO are low. Cardiopulmonary arrest is imminent. Interventions should be swift, methodical and aimed at increasing RV coronary driving pressure and decreasing RV afterload. Management should follow the ABCs of resuscitation:

1. Rule out ETT dislodgment or obstruction.
2. Rule out acute pulmonary process such as pneumothorax, atelectasis, or other cause of hypoventilation.
3. Increase FiO₂ to 1 and initiate iNO. If already in use, verify adequate administration and equipment function.
4. Administer inotropes and vasoconstrictors to increase the mean arterial blood pressure. Epinephrine, phenylephrine, and vasopressin are adequate choices.
5. In the postoperative setting, prompt evaluation for cardiac tamponade is required.
6. In cardiac arrest, activate ECMO.

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- Optionally, a picture of the author(s) may be submitted.
- No abstract should be submitted.
- The main text of the article should be written in informal style using correct English. The final manuscript may be between 400-4,000 words, and contain pictures, graphs, charts and tables. Accepted manuscripts will be published within 1-3 months of receipt. Abbreviations which are commonplace in pediatric cardiology or in the lay literature may be used.
- Comprehensive references are not required. We recommend that you provide only the most important and relevant references using the standard format.
- Figures should be submitted separately as individual separate electronic files. Numbered figure captions should be included in the main Word file after the references. Captions should be brief.
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Co - Director: Aldo Agnetti (Parma, Italy)
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Preview of Congenital Heart Disease (CHD) Symposium at SCAI 2011 Scientific Sessions - May 4-7, Baltimore, MD

By Frank Ing, MD, FSCAI and Daniel Levi, MD, FSCAI

We are excited to announce an expanded *Congenital Heart Disease (CHD) Symposium at SCAI 2011 Scientific Sessions* taking place in Baltimore, May 4-7. The CHD Symposium will still feature uninterrupted, focused programming on interventional therapies for congenital and structural heart disease...only more of it.

Among the new additions is the "Cardiovascular Thrombosis in the Pediatric Patient: Diagnosis and Treatment" workshop. This is a session not previously offered at any other pediatric or structural heart disease program, and it's necessary because so many of the complications seen in pediatric patients are secondary to clots.

Also new this year is the addition of the "Late Breaking Pediatric Trials" session. Richard Ringel, MD, FSCAI, of Johns Hopkins Children's Center will headline this program, presenting updated data on the COAST Trial.

John P. Cheatham, MD, FSCAI, of Nationwide Children's Hospital in Columbus, Ohio, will be delivering the Mullins Lecture. His presentation of "Past, Present and Future of Hybrid Procedures" will recount his pioneering work in developing new techniques and therapies.

"We are excited to announce an expanded Congenital Heart Disease (CHD) Symposium at SCAI 2011 Scientific Sessions taking place in Baltimore, May 4-7. The CHD Symposium will still feature uninterrupted, focused programming on interventional therapies for congenital and structural heart disease...only more of it."

Of course, the CHD Symposium will also include your tried-and-true favorites. We'll be bringing back the enormously popular "Brain Scratchers" session to challenge you to solve hemodynamic, angiographic or interventional mysteries and to provide solutions for less than routine cases in the congenital catheterization laboratory. The "I Blew It" sessions will also return to educate, entertain, and

shock with all the ways interventional cases can go awry and with the creative ways that our colleagues manage these complications.

And of course, our host city – Baltimore – is one of surprises and unique experiences that make it the charm of the Mid-Atlantic. *SCAI 2011* will take place entirely at the Hilton Baltimore, overlooking Camden Yards and located within the Inner Harbor district, including the National Aquarium in Baltimore. From Mount Vernon, the city's cultural hub, to Fell's Point, Federal Hill and everywhere in between, you are never more than a few steps away from a fresh and unique cultural experience.

To see additional information on this upcoming meeting, and to review the topic segments, faculty, etc. read pages 8-11.



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Congenital Heart Disease Program Co-Chair, SCAI 2011

Mattel Children's Hospital at UCLA
Los Angeles, CA USA



SCAI - CONGENITAL HEART DISEASE SYMPOSIUM

Location: Holiday 1
WEDNESDAY, May 4, 2011

Noon-1:30 pm - Cardiovascular Thrombosis in the Pediatric Patient: Diagnosis and Treatment - Moderators: TBD

- **Noon -12:30 pm - Workup and Treatment for Pediatric Thrombosis (For the Interventionist)** - Marilyn J. Manco-Johnson, MD
- **12:30-1:00 pm - Congenital Substrates Predisposing Cardiovascular Thrombosis in Pediatric Patients** - Leonardo R. Brandao, MD
- **1:00-1:30 pm - Transcatheter Treatment of Acute and Chronic Thrombosis** - Henri Justino, MD, FSCAI

1:30-2:00 pm - BREAK - VISIT EXHIBITS (Key Ballroom 5-12)

2:00-4:00 pm - Brain Scratchers - Moderators: TBD

5:00-7:00 pm - PRESIDENT'S RECEPTION

ACCREDITATION STATEMENTS

PHYSICIANS: The Society for Cardiovascular Angiography and Interventions is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. The Society for Cardiovascular Angiography and Interventions designates this education activity for a maximum of 23.75 AMA PRA Category 1 Credit(s)[™]. Physicians should only claim credit commensurate with the extent of their participation in the activity.

INTERNATIONAL PHYSICIANS: The American Medical Association has determined that physicians not licensed in the US who participate in this CME activity are eligible for AMA PRA Category 1 credit[™].

DOCTORS OF OSTEOPATHY: Category 2 credit will be awarded for formal educational programs that are ACCME accredited or AAFP-approved.

PHYSICIAN ASSISTANTS: AAPA accepts Category I credit from AOACCME, Prescribed credit from AAFP, and AMA PRA Category 1 CME credit for the organizations accredited by ACCME. The Society for Cardiovascular Angiography and Interventions is an accredited provider through the ACCME.

SCAI SUCCESSFUL COMPLETION STATEMENT: Certificates of Completion/Attendance are provided to registered attendees based upon completion of the evaluation. For questions regarding continuing medical education, please email CME@SCAI.org.

ABSTRACTS: An exciting array of abstracts will be presented at the conference. The top three abstracts will be selected by the Program Committee for special recognition. All presented abstracts will be printed in SCAI's journal, *Catheterization and Cardiovascular Interventions*.

Visit www.SCAI.ORG/SCAI2011 for the most up-to-date information on SCAI 2011. You may also register and learn more about hotel and travel accommodations.

SCAI

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SCAI - CONGENITAL HEART DISEASE SYMPOSIUM

Location: Holiday 1
THURSDAY, May 5, 2011

8:00 am-9:45 pm - Adult with the Single Ventricle - Moderator:
TBD

- **8:00-8:20 am - Preparing Your Cath Lab for Congenital Interventions in Adult Congenital Heart Disease: Equipment, Imaging and Personnel Needs, Special Considerations** - Michael J. Landzberg, MD, FSCAI
- **8:20-8:40 am - Advanced Imaging Techniques for the Adult Single Ventricle** - Thomas E. Fagan, MD, FSCAI
- **8:40-9:00 am - Transcatheter Fenestration Creation and Closure in the Adult Fontan** - Thomas K. Jones, MD, FSCAI
- **9:00-9:20 am - Unique Approaches to Catheterization of the Adult with SV** - Jamil Aboulhosen, MD, FSCAI
- **9:20-9:45 am - Role of the Cath Lab in Planning a Fontan Revision for the Adult with the Single Ventricle** - Eric Horlick, MD, FSCAI

9:45-10:15 am - BREAK - VISIT EXHIBITS (Key Ballroom 5-12)

10:15-11:00 am - Mullins Lecture: Past, Present and Future of Hybrid Procedures - John P. Cheatham, MD, FSCAI

11:00-11:45 am - Debate: Should Balloon Atrial Septostomy Always Be Done in d-TGA? - Moderator: TBD

- **11:00-11:15 am - Debate: PRO - Should Balloon Atrial Septostomy Always Be Done in d-TGA?** - Jonathan J. Rome, MD
- **11:15-11:30 am - Debate: CON - Should Balloon Atrial Septostomy Always Be Done in d-TGA?** - Phillip Moore, MD
- **11:30-11:45 am - Discussion** - Faculty

Noon-1:00 pm - LUNCH - VISIT EXHIBITS (Key Ballroom 5-12)

1:15-2:15 pm - Abstract Session I - Moderator: TBD

2:15-3:00 pm - "I Blew It" Session I - Moderator: TBD

3:00-4:00 pm - Congenital Heart Disease Council Meetings



SCAI Monthly Column

Dr. Lynn Peng Recognized as SCAI ELM Fellowship Recipient

Congratulations to Lynn Peng, MD, Clinical Assistant Professor of Medicine within the Division of Pediatric Cardiology at Lucile Packard Children's Hospital at Stanford in Palo Alto Calif. Dr. Peng has been recognized as a member of the inaugural class of SCAI ELM Fellowship recipients.

The SCAI Emerging Leader Mentorship (ELM) Program in partnership with the American College of Cardiology (ACC) and the Cardiovascular Research Foundation (CRF) was charged with finding a small, highly selective group of up-and-coming physicians and facilitating their transition into the next generation of great thinkers, presenters, teachers and national leaders. Dr. Peng was among 10 fellows selected from 62 truly outstanding and unique applicants.

ELM Fellows will participate in six training sessions over a two year period, timed with the SCAI, TCT and ACC annual conferences, and will be assigned a Mentor specifically chosen to match their interests and aspirations. To learn more visit www.scai.org/ELM.

Plan to Attend SCAI CHD Council Meeting at SCAI 2011

Want to help shape the future of congenital interventional therapies? Then, you are encouraged to plan to attend the SCAI CHD Council Meeting at *SCAI 2011 Scientific Sessions* in Baltimore on May 4. We'll also be meeting again at PICS in Boston in late July.

There are a lot of important issues to discuss and get involved in ranging from the development of a Core Curriculum and Training Standards for pediatric interventional cardiology to working with the FDA on pediatric cardiovascular device and trial development. Check www.SCAI.org for further details on upcoming CHD Council Meetings.

Join the Webolution: SCAI Calls for Contributions to CHD Website

SCAI is preparing to launch a special interest page specific to interventional therapies for Congenital Heart Disease on SCAI.org and we need your help!

As part of this project being spearheaded by Makram R. Ebeid, MD, FSCAI, and Russel Hirsch, MD, FSCAI, SCAI is currently building a comprehensive library of angiograms of unique lesions (single ventricle, heterotaxy, pulmonary atresia, etc.). Have an interesting angiogram that might be a valuable resource for our community? Please send your images or AVI files, with a bit of background information to us at egrammer@scai.org.

Remember to remove any personal identifiers. We'll be recognizing the very best images in an Interesting Image of the Week feature on the site.

Make an IMPACT: Help Us Meet the Need for Data on CHD Patients With New Registry

Congenital Heart Disease (CHD) occurs in approximately one of every 120 births, making it the most common birth defect in the United States. Thanks to medical and surgical advances, many children born with CHD live well into adulthood. However, until now, no resource for sufficiently collecting and analyzing quality improvement data related to these efforts has been available.

Now, facilities treating CHD patients can enroll in the new IMPACT Registry™, collect CHD data, and receive benchmark reports that will allow them to measure performance-related CHD interventions and identify ways to improve outcomes. Created through the ongoing commitment of SCAI, the American College of Cardiology Foundation, and the American Academy of Pediatrics, the IMPACT Registry (IMproving Pediatric and Adult Congenital Treatment) will help clinicians assess the prevalence, demographics, management, and in-hospital outcomes of CHD patients who undergo diagnostic catheterization and catheter-based interventions.

For more information or to enroll, contact the IMPACT Registry team at 800-257-4737 or ncdr@acc.org.



SCAI - CONGENITAL HEART DISEASE SYMPOSIUM

Location: Holiday 1
FRIDAY, May 6, 2011

8:00 am-9:45 pm - Dress for Success: Anticipation, Preparation, Prevention - Moderator: TBD

- **8:00-8:20 am - Pulmonary Artery Stents** - Frank F. Ing, MD, FSCAI
- **8:20-8:40 am - Melody Valve** - Doff B. McElhinney, MD, FSCAI
- **8:40-9:00 am - Use of the Radiofrequency Wire** - David G. Nykanen, MD, FSCAI
- **9:00-9:20 am - Hybrid Norwood** - Lee N. Benson, MD, FSCAI
- **9:20-9:45 am - The Covered Stent** - Mario Carminati, MD, FSCAI

9:45-10:15 am - BREAK - VISIT EXHIBITS (Key Ballroom 5-12)

10:15-11:45 am - Translational Interventional Research - Moderator: TBD

- **10:15-10:35 am - Bench to Bedside: New Designs for Occluder Devices** - Zahid Amin, MD, FSCAI
- **10:35-10:55 am - Role of the Interventionist in Translational Genetics Research** - Charles E. Mullins, MD, FSCAI
- **10:55-11:05 am - Bioabsorbable Stents** - Daniel S. Levi, MD, FSCAI
- **11:05-11:25 am - Translational Research in Kawasaki Coronary Disease: The Interventionalist Role** - R. David Fish, MD
- **11:25-11:45 am - Discussion** - Faculty

Noon -1:15 pm - LUNCH - VISIT EXHIBITS (Key Ballroom 5-12)

1:15-2:15 pm - Abstract Session II - Moderator: TBD

2:15-3:00 pm - "I Blew It" Session II - Moderator: TBD

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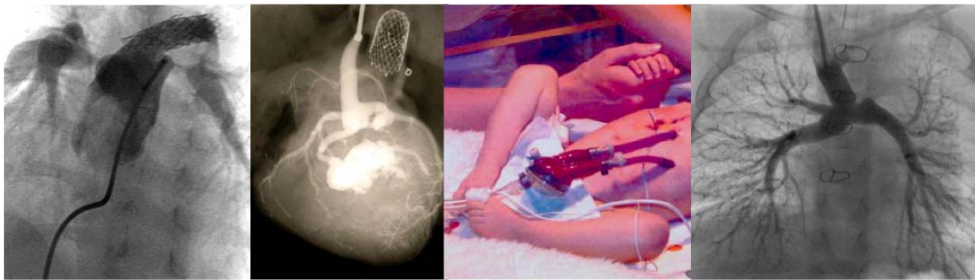


HYPOPLASTIC LEFT HEART SYNDROME

AND OTHER FUNCTIONAL UNIVENTRICULAR HEART DISEASE

2011

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DEAR PARTICIPANT

We are delighted to invite you to the 5th Toronto Symposium, 'Hypoplastic Left Heart Syndrome and Other Functionally Univentricular Heart Disease.' This is the 5th meeting of the Cardiac Symposium. This year we will dedicate the entire meeting to a detailed analysis of the hypoplastic left heart and expect it to live up to the success of the previous symposia.

Once again, we have invited a world-class faculty of scientists, physicians, surgeons and allied professionals to participate with the Toronto team in a 'state of the art' conference.

The Toronto Symposium aims to be a little different from the usual medical meeting. The title of each lecture, no matter whether addressing issues of basic science or clinical management, is framed as a topical question. Consequently we expect that the answers will be of direct relevance to your practice. This meeting will be suitable for anyone working in the field of congenital heart disease, but please note that we are limited to just 250 places, and have sold-out prior to previous meetings.

So register early to avoid disappointment!

While there are some concurrent sessions, be assured there is no need for you to miss anything. Each of the lectures will be recorded, and each participant will receive a DVD shortly after the meeting. Again, this is a little out of the ordinary, showing both a video of the lecturer in real time, and the simultaneous Power-Point presentation. An example of the format can be seen on our symposium website at www.sickkids.ca/Centres/heart-centre/Cardiac-symposium. Copies of the DVD's from previous symposia can be purchased by e-mailing the Symposium organizer at: cardiac.symposium@sickkids.ca

We are looking forward to a focused, detailed, and rewarding meeting, located in the heart of Toronto's stylish, historic Yorkville. We hope you will be able to join us.

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5TH CARDIAC SYMPOSIUM HYPOPLASTIC LEFT HEART SYNDROME AND OTHER FUNCTIONALLY UNIVENTRICULAR HEART DISEASE

June 5 - 7, 2011 • Four Seasons, Toronto, Canada

COURSE OBJECTIVES

- To bring together experts in the field of Hypoplastic left heart syndrome and its treatment
- To explore the contemporary understanding of heart development, physiology and pathophysiology of Hypoplastic left heart syndrome
- To encourage a multidisciplinary approach to the fetal, preoperative and late postoperative management

REGISTRATION FEES (All in Canadian Dollars)

	to March 4	from March 5
MD	\$575	\$675
Trainee/Nurse/Allied Health	\$425	\$525

ACCOMMODATIONS Participants are responsible for making their own reservations. Special rates are available for participants of this event before March 4, 2011. Hotel reservations: 416-964-0411

CME CREDITS Application in process for 23 credits.

Please email all questions to: cardiac.symposium@sickkids.ca. You will receive a response within 48 hours.

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Dr. Doff McElhinney (USA)
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Please note that we will be holding a pre-symposium course on the 1st to 3rd of June, 2011.

This exciting course brings together experts in cardiac anatomy and imaging, providing an intensive discussion of the correlation between cardiac morphology in the specimen and its assessment by 3 dimensional techniques in life. Atrial arrangement and venous connections, atrial and ventricular septal defects, atrioventricular septal defect, common arterial trunk, and Tetralogy of Fallot with MAPCA's will each be subject to a half day discussion of anatomy, diagnosis and treatment.

Professor Robert Anderson will present live demonstrations of cardiac anatomy, to be followed by relevant discussions and presentations regarding 3 dimensional echo, MRI, and CT scanning and surgical implications. There will be three educational streams. The first being a basic level stream for Canadian Royal College residents. One hour breakout sessions for this stream will primarily involve hands-on teaching with cardiac specimens. The final afternoon session will comprise a mock OSCE exam. The second stream will be for more senior trainees. Breakouts will include 3 dimensional reconstruction echo workstations, as well as 3 dimensional and 4 dimensional analysis of MRI and CT scans.

These streams will be strictly limited to 20 attendees. Finally, a general stream will be open to all others wishing to attend the didactic elements of the course. We do hope that this will be a valuable supplement for those attending the Toronto Symposium, but also welcome those that only wish to attend this pre-symposium course.

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Heart-Stopping Conference: Sudden Cardiac Arrest in Children and Adolescents

By Leslie Anne Rabbitt, MPH

On January 14 and 15, 2011, CHOC Children's Hospital presented the *Sudden Cardiac Arrest in Children and Adolescents Conference* at the Disney Grand Californian Resort and Spa in Anaheim, California. This popular first-time CME conference drew physicians from 16 states and Canada. The audience comprised approximately a third pediatric cardiologists, a third physicians from other specialties and a third nurse practitioners, nurses and allied health professionals. Fifteen distinguished pediatric faculty presented on the genetics, clinical mechanisms and disease substrate of unanticipated cardiac death in apparently healthy children, as well as those with known congenital cardiac disease. The conference also featured several animated debates and interactive expert panels. The live Audience Response System allowed for instant polling of participants as conference content enriched their understanding of this important field of inquiry.

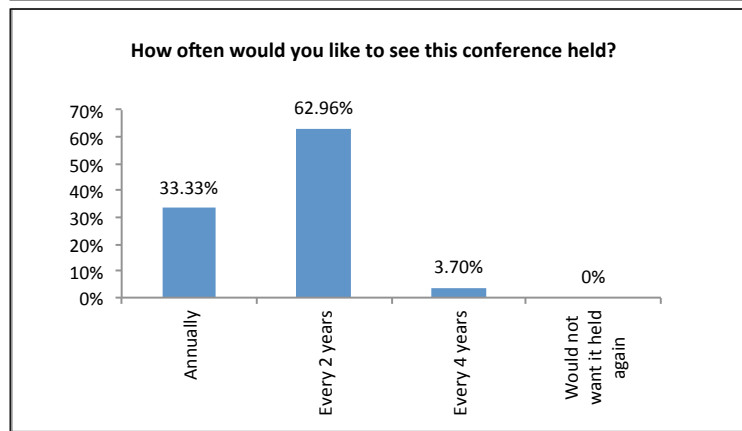
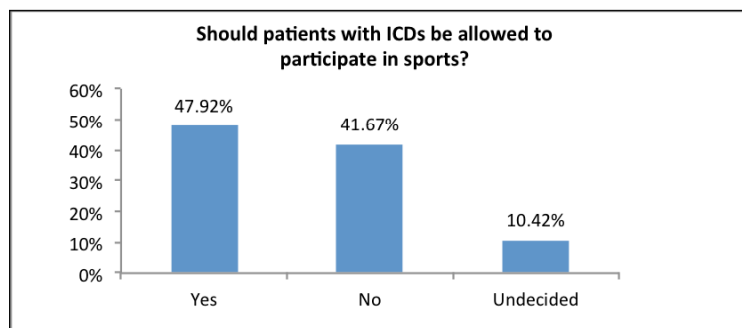
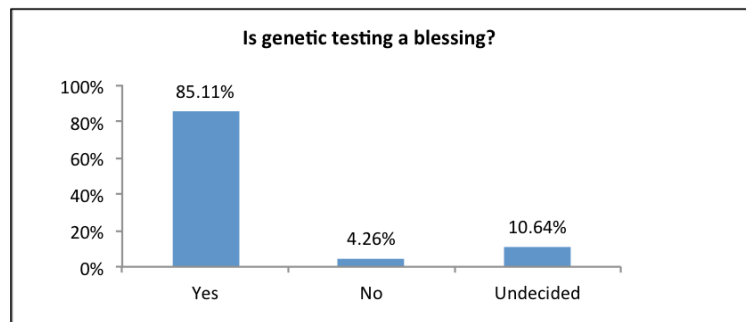
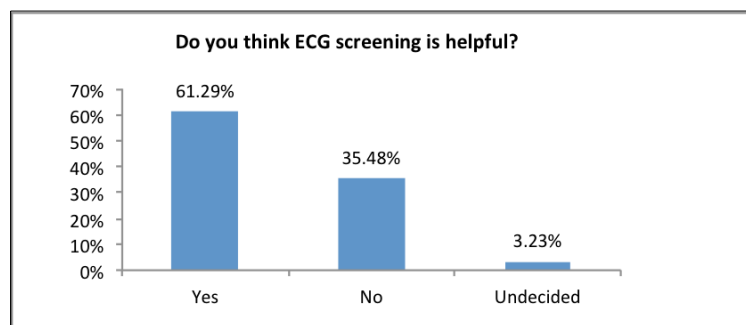
Program Director, Pediatric Electrophysiologist Anjan Batra, MD of CHOC Children's Hospital and University of California Irvine, introduced the conference with a disease-based review. CHOC Pediatric Cardiologist Anthony Chang, MD, MBA, MPH explored similarities and differences between ventricular modeling in cardiomyopathy vs. athlete's heart. Pediatric Electrophysiologist Yaniv Bar-Cohen, MD of Children's Hospital Los Angeles explained subtle and not-so-subtle waveform anomalies in cardiac channelopathies. Stuart Berger, MD, Professor of Pediatric Cardiology for the Medical College of Wisconsin gave a

thorough review of other causes of sudden cardiac arrest in youth, such as commotio cordis and myocarditis.

Development of sudden cardiac arrest risk in children with known congenital heart disease was explored by Michael J. Silka, MD, Chief of Pediatric Cardiology at Children's Hospital Los Angeles. A discussion of non-cardiac arrest in the young athlete by UC Irvine Pediatric Pulmonologist and NIH CTSA award recipient Dan Cooper, MD ensued. Dr. Cooper included a fascinating exposition of the clinical cascade resulting in rare and potentially deadly exercise-based anaphylaxis.

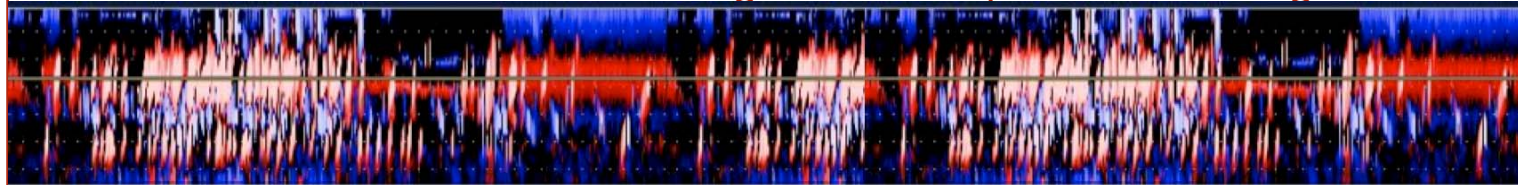
Day One of the Conference concluded with a vigorous debate between Dr. Chang of CHOC Children's Hospital and Richard A. Friedman, MD, MBA, Electrophysiologist from Texas Children's Hospital regarding mandatory ECG screening in all school-age children.

The keynote address opened Day Two with an intriguing exploration of the state of pre- and post-mortem genetic testing for sudden death predisposing cardiomyopathies and channelopathies. Michael J. Ackerman, MD, PhD of the Windland Smith Rice Sudden Death Genomics Laboratory at the Mayo Clinic offered a sophisticated yet accessible examination of the diagnostic, prognostic and therapeutic



Selected results from the Instant Audience Response Poll at the Sudden Cardiac Arrest in Children and Adolescents Conference

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“It is the Conference Steering Committee’s wish that the academic content presented by the nationally recognized SCA faculty will go far to improve diagnosis, treatment and prevention of Sudden Cardiac Arrest in Children and Adolescents.”



remain unclear and risk stratification for sports participation in youth with known heart disease elicited energetic audience interaction. For the Day Two closing highlight, a rock ‘em, sock ‘em debate between Kevin Shannon, MD, Electrophysiologist and Professor of Pediatrics at UCLA and Ian Law, MD, Electrophysiologist and Professor of Pediatrics at the University of Iowa ensued on whether patients with ICDs should be allowed to participate in competitive sports.



Sciences University about the virtues (or not) of genetic testing of patients at risk for SCA.

The controversial topic of screening for patients at risk for SCA got a robust workout featuring Conference Faculty Yaniv Bar-Cohen, MD on the utility of sports pre-participation assessments. Advanced cardiac imaging expert Beth Printz, MD, PhD of Rady Children’s Hospital demonstrated use of echocardiography and cardiac MRI as Sudden Cardiac Arrest (SCA) screening tools. The controversy surrounding risk of SCA with ADHD stimulant drugs was chronicled by UC Irvine’s Chief of Developmental and Behavioral Pediatrics, Marc A. Lerner, MD. Finally, Rady Children’s Hospital Electrophysiologist James C. Perry, MD reviewed risk factors for life-threatening arrhythmias in adults with congenital heart disease.

Secondary prevention, a hot topic among clinicians and the community alike rounded out Day Two of the conference. Questions about utility vs. liability of AED programs, why some children experience SCA for reasons that

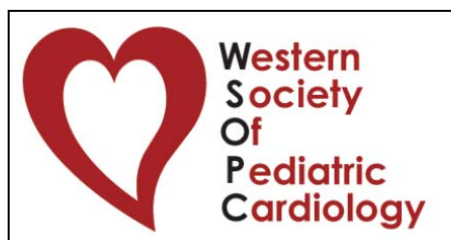
Review of course evaluation comments from physician and nurse attendees of *Sudden Cardiac Arrest in Children and Adolescents* indicated high appreciation for the academic content, pace and audience interaction aspects of the conference. The overwhelming majority of participants requested this conference be repeated in future years. It is the Conference Steering Committee’s wish that the academic content presented by the nationally recognized SCA faculty will go far to improve diagnosis, treatment and prevention of Sudden Cardiac Arrest in Children and Adolescents.

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impact of genetic tests. Special note was made of the “genetic purgatory” of high false positives. Dr. Ackerman skillfully illustrated the fundamentally probabilistic nature of these diagnostic assays.

A spirited debate ensued between Dr. Batra and Seshadri Balaji, MD, Director of Pediatric Arrhythmia, Pacing and EP at Oregon Health

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Neonatal Cardiac Rhabdomyoma in Twin Boys

By Samir Atmani, MD

Introduction

Symptomatic cardiac rhabdomyomas and obstructive diffuse forms constitute a rare entity at birth. They are associated with tuberous sclerosis of Bourneville (TSB) in about two thirds of cases. The diagnosis is based on the ultrasound and the prognosis depends on their localization. We report a diffuse and obstructive form of TSB in a twin.

Observation

We reported cases of Ayman and Ahmed respectively full-term twin neonates of consanguineous parents. Upon birth, they presented with both perioral cyanosis and respiratory distress. At admission, SaO₂ was at 77% in the first twin, and 70% in the second, with signs of respiratory inconsistency. The cardiac examination revealed a continual murmur in both cases, in addition to pulmonary systolic murmur in

the second case. Both infants had hypopigmented and achromic spots remarkable on the lower limbs, at the abdominal level and the chest (six spots on the first case, and 8 spots on second) [Figure 1]. After oxygenation treatment using oxygen mask, SaO₂ had improved and became respectively 98% in the first case, and 97% in the second. The Thoracic radiography objectified a diffuse bronchial infiltration both twins.

In both twins, the ultrasound exploration demonstrated a PDA and numerous small lesions disseminate in the two ventricles with a large obstructive mass measuring 2 cm suspended in right outflow trunk and the pulmonary valve within the second twin [Figure 2]. The cerebral CT-scan showed typical Bourneville tuberous sclerosis lesion.

Antibiotic and propanolol treatments were started immediately. Progressively, the first case status improved, whereas, the second



Figure 1: Numerous achromic spots on lower limbs.

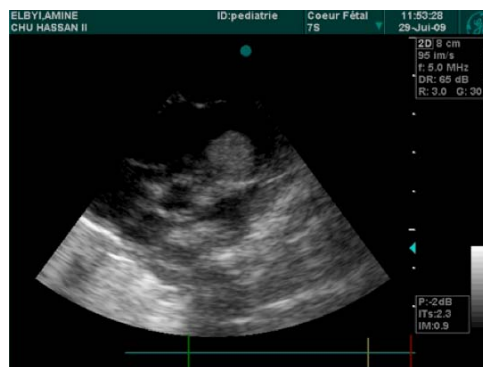
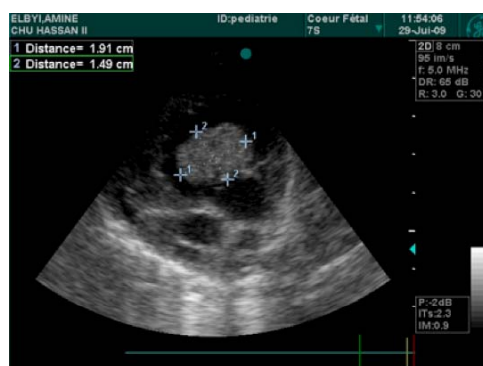
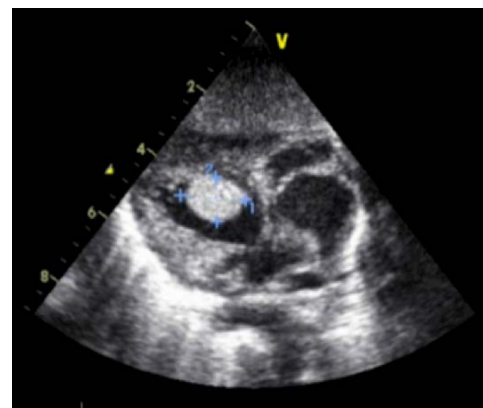


Figure 2 (top); Figure 3 (middle); Figure 4 (bottom): Enormous endocardial mass 2 cm size, appended to the pulmonary outflow trunk.

infant died suddenly, probably by pulmonary trunk obstruction.

At three months of life, the surviving twin developed epilepsy, which is now controlled successfully by sodium valproate. The clinical follow-up showed non-recurrent symptoms and serial ultrasound examination showed a decreased tumor mass.



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“The clinical manifestations of cardiac rhabdomyomas depend especially on the localization in the heart; they are varied and polymorphic, and often asymptomatic. Particular forms of localization might impair the vital prognosis.”

Discussion

The cardiac tumors in child and fetus represent about 1% of cardiac disorders diagnosed in-utero. The most frequent histological form in the fetus is the cardiac rhabdomyoma.^{1,2,3} Forty-four cases were rhabdomyomas among a cardiac series of 56 tumors collected along several decades. 60-80% of children with rhabdomyoma are STB.⁴

The diagnosis is evoked by the presence of large echogenic masses, inserted in the cardiac cavities likely blocking the atrio-ventricular outflow and the aortic or pulmonary ejection.^{5,6} They might be single or multiple, either in the interventricular septum or in walls of the two ventricles, or exceptionally in the atrium walls.^{3,5,6}

The prenatal diagnosis using antenatal ultrasound is possible after 22 weeks of amenorrhea.³

Hydrops foetalis, conductive disorders, or hypertrophic cardiomyopathy by massive infiltration are the main prenatal manifestation.⁶ Intrauterine death, as well as sudden death, immediately after birth has attributed to them. After delivery, these tumors are usually asymptomatic,^{6,7} and might be discovered during a routine ultrasound screening in TSB condition.⁶ However infrequently, they could initiate

neonatal cardiac deficiency by obstruction or rate/rhythm disorders as Wolf-Parkinson White Syndrome. Also respiratory distress or thrombo-embolic stroke could be the revelator symptom.^{6,7,8}

The clinical examination could be normal, or associating TSB signs. The cardiac examination might show systolic pulmonary or aortic murmur such found in the case of the second twin. The thoracic radiography could be normal.

Doppler-ultrasound is the key diagnostic tool demonstrating the masses, their extension and localization, specifying their number, and assesses their hemodynamic characteristics.⁶

Although difficult to achieve in the neonate, the cardiac MRI allows a better study of the parietal infiltration.^{3,9}

Rhabdomyomas have been known to spontaneously regress. However, serious symptoms may precipitate the need for surgical removal. Such as our second twin, who probably had, acute obstruction of the pulmonary trunk.^{4,7,8,10}

Conclusion

The clinical manifestations of cardiac rhabdomyomas depend especially on the localization in the heart; they are varied and polymorphic, and often asymptomatic. Particular forms of localization might impair the vital prognosis.

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Medical New, Products and Information

UCSD Study Reveals Pediatricians Overlook Kawasaki Disease in Extremes of Pediatric Age Ranges

Researchers at the University of California, San Diego (UCSD) School of Medicine reported in the August 10, 2010 issue of *Pediatric Infectious Disease Journal* that a significant number of pediatric physicians fail to diagnose Kawasaki disease in children younger than six months and older than eight years. This childhood disease is reported in about 5,000 children a year in the United States.

First author, Pia Pannaraj, MD, UCSD pediatric resident, said a previous study showed that delayed diagnosis of Kawasaki Disease was a significant risk factor in the development of coronary abnormalities that can lead to heart muscle damage and deadly aneurysms.

"The purpose of the current study was to understand the basis of the delayed diagnosis," she said. "We wanted to know the cause so we could help make recommendations to prevent the delay and the subsequent coronary problems that can result."

The study's senior author Jane Burns, MD, Professor of Pediatrics, UCSD School of Medicine Department of Pediatrics, says the finding is significant because failure to diagnose and treat the disease at the extremes of the pediatric age range puts children at increased risk for coronary artery abnormalities and risk of heart attack later in life.

"Despite the availability of effective treatment for Kawasaki disease, children continue to needlessly suffer preventable coronary artery damage associated with the disease," says Burns. "Numerous global studies have shown children can be at risk from as early as one month to their teens. General pediatricians and pediatric infectious disease specialists need to consider Kawasaki disease when examining all children with prolonged fever accompanied by rash or red eyes, regardless of the patient's age."

Tomisaku Kawasaki, MD of Japan, first diagnosed Kawasaki Disease over 30 years ago. Kawasaki disease is characterized by inflammation of blood vessels throughout the body, and is accompanied by high fevers, rashes, bloodshot eyes, swelling of the hands and feet, redness of the mucous membranes in the mouth, throat and lips, and swollen neck lymph nodes. The disease and symptoms are treatable with gamma globulin. Full recovery can be made and heart damage prevented if treatment is begun within the first ten days. However in cases where children have the disease and do not receive treatment, up to 25% can develop lethal coronary artery problems. Although researchers do not know the cause of Kawasaki disease they have discovered certain genetic backgrounds that affect KD susceptibility. The disease affects males almost twice as often as females. Kawasaki disease afflicts children of all races, but physicians see it most often among children of Asian descent. The highest occurrences of the disease are reported in the winter and spring months with a second smaller peak in mid-summer.

For this study, Pannaraj and colleagues, Christena Turner, PhD, UCSD Department of Sociology, and John Bastian MD, Director of Immunology

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- Fetal detection of congenital heart diseases in Ile de France: definitive results from 1982 to 2010 and a proposed new classification of CHD
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- Congenital heart diseases in twins: 250 sets
- Diagnosis and Treatment of Fetal Heart Failure
- Anomalies of pulmonary venous return: fetal detection and results
- Prevention of CHD
- Arterial malposition of the great arteries: Fetal detection and results
- Double discordances atrioventricular and ventriculoarterial: Fetal detection and results.
- Echocardiographic measurements of RV Volumes Which Technique to use?
- Value of Cardiac MRI - Imaging modality Tissue Characterization, Volumes
- Integration of Cardiac MRI and Echocardiography - Initial Toronto experience
- The value of Cardiac MRI in CHD: indication, pitfalls, benefits and examples
- Preoperative management and postoperative results of HLHS
- "The Isabelle Jue Lecture" - Evolutionary Development of the Heart
- HLHS and Tricuspid Regurgitation: Which comes first after Norwood
- TV anatomy in HLHS
- Melody Valve: Percutaneous pulmonary valve implant experience
- Exercise Echocardiography and Assessment of Systolic and Diastolic Reserve
- Assessment of the effect of RV Pressure or Volume Load on LV function by 2D Strain
- Echocardiographic Measurement of Tissue Velocities and Deformation. How do the different techniques compare?
- Echocardiography in Dilated Cardiomyopathy. How good are our Measurements
- Echo and Stress Echo in Dilated Cardiomyopathy
- The Macartney Lecture - "The importance of Perinatal Cardiology on the outcomes of CHD"
- The Mitral valve by three-dimensional Echocardiography: Valve Anatomy and Complex Lesions
- Echocardiography of the Tricuspid Valve
- Sudden Cardiac Death in Young People

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at Children's Hospital and Health Center - San Diego, sent a questionnaire to general pediatricians and pediatric infectious disease specialists listed in the American Academy of Pediatrics Membership Directory for San Diego County, the physician directories for San Diego's five major healthcare systems and the Pediatric Infectious Disease Society Membership Directory. Of the 227 general pediatricians and 651 pediatric infectious disease physicians contacted for the survey, 58.1% of pediatricians and 53% of pediatric infectious disease physicians returned the questionnaires. Of the general pediatricians from San Diego County who responded, 57.3% did not consider a Kawasaki disease diagnosis in children under six months of age, and 51.6% did not consider the disease in children older than eight. Of the pediatric infectious disease specialists who answered, 26.5% did not consider KD in their diagnosis of children less than six months, and 25% did not consider it in children over eight years of age.

According to Burns, the San Diego County Health Department Epidemiology Unit has documented 318 patients diagnosed with KD from January 1, 1998 to December 31, 2003. Of these patients, 8.3% were under 6 months of age and 18.1% were older than five years.

Patient-Derived Stem Cells Could Help Test Cardiac Disease Treatments

Skin cells from a patient with an inherited heart disease were the seeds of a stem cell experiment that could help researchers test specific treatments for the disease, known as long QT Syndrome. The research results appeared in the January 16, 2011 issue of the journal *Nature*.

Scientists from the Technion-Israel Institute of Technology turned the skin cells into a type of all-purpose stem cell called induced pluripotent stem cells, or iPSCs. Prof. Lior Gepstein of the Faculty of Medicine and colleagues then coaxed these stem cells — which have the capability to become any cell type in the human body — to become cardiac cells. The newborn heart cells showed an abnormal electrical activity in the laboratory, recapitulating clinical presentation of the long QT syndrome patient, making them useful for studying this potentially lethal disorder.

The research team, which included Ilanit Itzhaki, Leonid Meizels, Irit Huber and colleagues, was then able to test several types of drugs to find out how they might aggravate or alleviate long QT symptoms in the cells.

The study can help scientists learn more about how a disease like long QT Syndrome works at the cellular level, Gepstein said. But it also offers a glimpse at the future of personalized medicine, where a person's own cells can be used to determine which treatments might work best—or should be avoided—for a particular condition.

Beyond its implications for personalized treatments, the Technion study offers a new way to study diseased cells that can't be removed easily from the body, said Jeffrey Olgin, MD, Chief of Cardiology and Cardiac Electrophysiology at the University of California San Francisco. "This has been challenging in heart disease since heart biopsies are difficult to obtain," he explained.

Long QT Syndrome is a disease that affects the heart's ability to recharge itself after each heartbeat. In people with the disease, the heart's electrical system takes longer than normal to recover between each beat. This disturbance can cause a fast, chaotic heartbeat that

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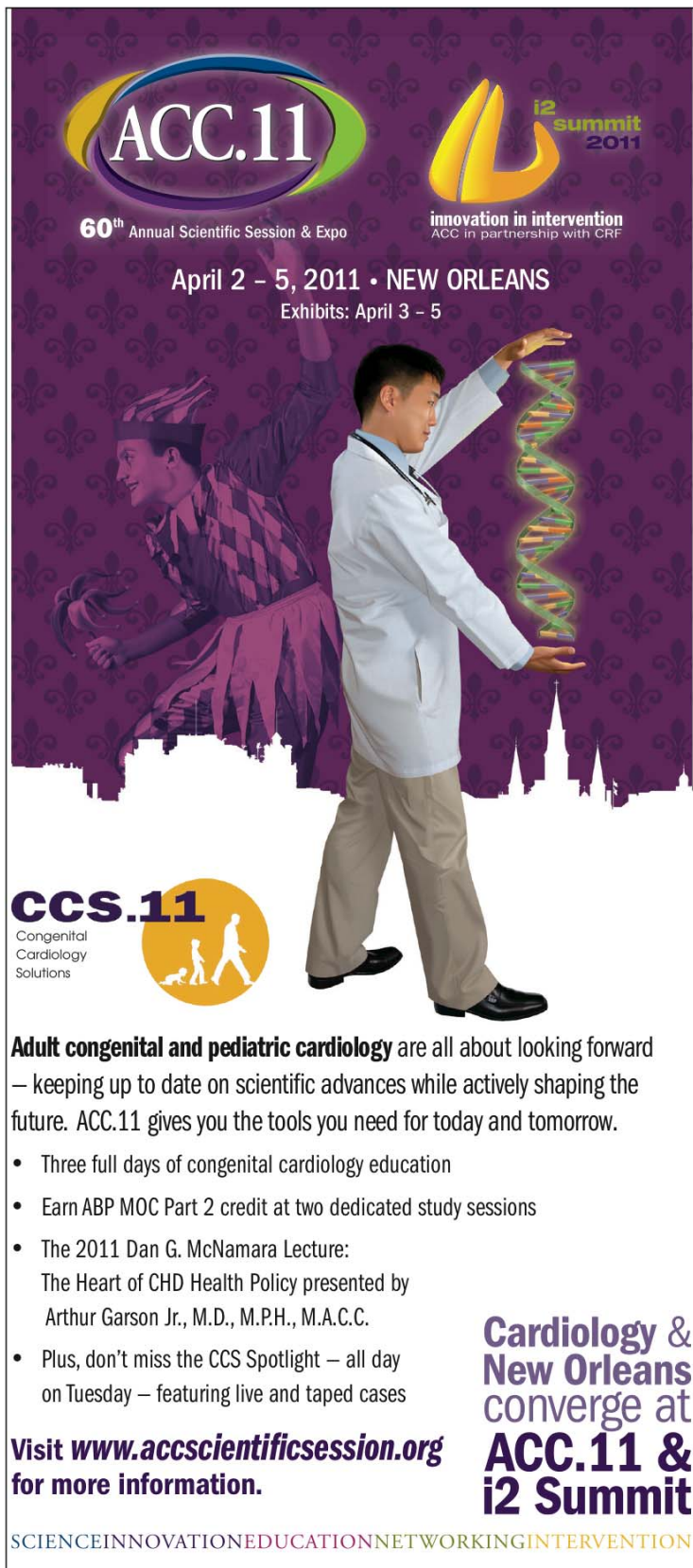
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triggers fainting, seizures, and can result “in sudden death in otherwise healthy young individuals,” Gepstein said.

Some patients acquire the disorder after taking certain medications, but the disease is also caused by an array of inherited genetic defects that affect the proteins involved in recharging the heart. In the *Nature* study,

Gepstein and colleagues used skin cells from a 28-year old woman with type-2 LQTS, which is caused by a single genetic mutation.

Long QT Syndrome is a good disease to examine using iPSCs, said Gepstein, because it is caused by a mutation in a single gene, and there is a clear relationship between the mutation and how the cell behaves as a result. In this case, the individual cardiac cells derived from the stem cells demonstrated the same long recharging period and arrhythmia common in the hearts of long QT Syndrome patients.

In the study, the disease “could be demonstrated and studied at the single-cell or multicellular level, but it doesn't require an entire organ, which of course we cannot create,” said Gepstein.

“This is something that in the past could only be done by developing mouse models or expressing a mutation in a non-cardiac cell,” Olgin agreed.

Gepstein said researchers around the world are also using iPSCs to study other heart diseases and nervous system disorders such as Parkinson's Disease.

Finally, Gepstein commented that “the ability to generate heart cells from the same patients may be potentially used in the future also for additional fields such as for the emerging field of regenerative medicine, where they could be used in cell therapy and tissue-engineering strategies aiming to improve the function of failing hearts.”

Study Find That Electronic Fetal Heart Rate Monitoring Greatly Reduces Infant Mortality

In a study presented at the Society for Maternal-Fetal Medicine's (SMFM) February annual meeting, The Pregnancy Meeting™, in San Francisco, researchers presented findings that prove that the use of fetal heart rate monitors lowers the rate of infant mortality.

There have been a handful of small studies conducted in the past that looked at the effectiveness of fetal heart rate monitors, but none of them were large enough to be conclusive.

“There was some criticism within the obstetric community that fetal heart rate monitoring was quickly accepted technology without proof that it was effective,” said Suneet P. Chauhan, MD, one of the study's authors. “We thought we could use data from the National Birth Cohort to get a large enough sample to gauge its effectiveness.”

Chauhan and his colleagues (Han-Yang Chen, Cande Ananth, Anthony Vintzileos and Alfred Abuhamad) used a sample of 1,945,789 singleton infant birth and death records from the 2004 National Birth Cohort. Multivariable log-binomial regression models were fitted to estimate risk ratio to evaluate the association between electronic fetal heart rate monitoring (EFM) and mortality, while adjusting for age, race, marital status, education, smoking, and the infant's gender.

The results showed that in 2004, 89% of singleton pregnancies had EFM. EFM was associated with significantly lower infant mortality (adjusted RR 0.75; 95% CI 0.69, 0.81); this was mainly driven by the lower risk of early neonatal mortality (adjusted RR 0.50; 95% CI 0.44, 0.57) associated with EFM. In low-risk pregnancies, EFM was associated with decreased risk for low (< 4) 5 min Apgar scores (RR 0.54; 95% CI 0.49, 0.51), whereas in high risk pregnancies EFM was also associated with decreased risk of neonatal seizures (adjusted RR 0.65; 95% CI 0.46, 0.94).

The study demonstrates that the use of EFM decreased early neonatal mortality by 53%.

Study Examines Earlier Use of Heart Pumps in Growing Group of Heart Failure Patients

University of Michigan, University of Pittsburgh to lead REVIVE-IT study with \$13.3 million in support from NHLBI, HeartWare

The University of Michigan Cardiovascular Center and the University of Pittsburgh have been awarded \$13.3 million to explore the potential benefits of heart devices for the large and growing group of Americans with heart failure.

The National Heart, Lung and Blood Institute and HeartWare International, a maker of left ventricular assist devices, are sponsoring the study of earlier access to these devices that support the circulation of patients with failing hearts.

In REVIVE-IT, researchers will compare whether non-transplant eligible patients with heart failure less advanced than that of current LVAD recipients do better with implanted devices than with current medical therapy.

Principal investigators include Keith Aaronson, MD, MS, Medical Director of the Heart Transplant Program and Center for Circulatory Support at the U-M Cardiovascular Center, Francis A. Pagani, MD, PhD, Surgical Director of the Heart Transplant Program and the Center for Circulatory Support at the U-M and Robert Kormos, MD, Director of the UPMC Artificial Heart Program and Co-Director of the UPMC Heart Transplantation Program.

"The new study allows us to examine the use of heart devices earlier in the cascade of heart failure," says Aaronson, Associate Professor of Medicine at the U-M medical school.

For most patients, either a past heart attack or certain conditions such as hypertension, heart muscle diseases, abnormal heart valves, or diabetes has lead to heart failure.

LVADs are currently used in patients with very advanced heart failure as a last resort to help them survive the wait for a heart transplant, or serve as a permanent alternative to heart transplantation.

"In REVIVE-IT we'll test the theory that heart failure patients whose condition impairs their daily lives, but who have not suffered serious consequences such as organ damage, malnourishment or immobility, would benefit from earlier implantation of an LVAD," says Pittsburgh's Kormos.

Kormos is also co-principal investigator of the NHLBI-sponsored Interagency Registry for Mechanical Circulatory Support, which contains information on nearly 2,000 approved assist devices.

"Ventricular assist devices have been shown to improve both the quality and length of life of late-stage heart failure patients," says J. Timothy Baldwin, PhD, REVIVE-IT Trial Project Officer, Division of Cardiovascular Sciences, NHLBI. "This trial promises to help us learn if there are advantages to providing these devices before patients reach late-stage heart failure."

The REVIVE-IT study device will be HeartWare's left ventricular assist device the HVAD, a battery- operated continuous blood flow pump

that's surgically placed within the heart and the pericardial space surrounding the heart.

The pilot study will include 100 patients from selected US hospitals, including the U-M and Pittsburgh. Site selection for the study will begin later this year. The U-M's Michigan Institute for Clinical and Health Research will coordinate the study.

"Our work may advance the treatment of heart failure by evaluating whether technology now reserved for very severe heart failure is ready for application to a broader group of patients in need," says Pagani, a cardiac surgeon and Professor of Surgery at the U-M.

U-M's Center for Circulatory Support is a multidisciplinary team of physicians, surgeons and allied health care providers dedicated to the care of patients with advanced heart failure or cardiogenic shock. Center clinicians and researchers have provided leadership in the clinical investigation of most of the implantable circulatory support devices in use today.

"The University of Michigan and University of Pittsburgh have been leaders in exploration and development of new technologies for mechanical circulatory support," says Doug Godshall, President and CEO of HeartWare International. "We look forward to supporting their efforts, as they direct this first-of-its-kind clinical study."

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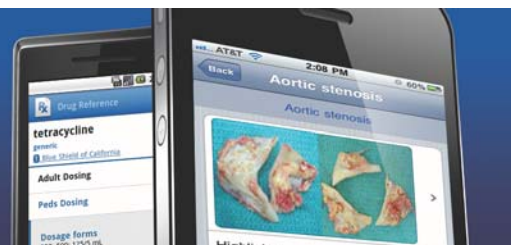
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