CONFERENCE PROCEEDINGS

Volume 10, May 2014

The Proceedings of the Tenth International Conference on

Pediatric Mechanical Circulatory Support Systems & Pediatric Cardiopulmonary Perfusion

Akif Ündar, PhD, Editor

May 28-31, 2014, Philadelphia, PA, USA

PENNSTATE HERSHEY Children's Hospital

The Children's Hospital *of* Philadelphia®

PENNSTATE HERSHEY Pediatric Cardiovascular Research Center

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Akif Ündar, PhD

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Vinay M. Nadkarni, MD, USA
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Alexis Topjian, MD, USA
Akif Ündar, PhD, USA
Shigang Wang, MD, USA
Wei Wang, MD, PhD, China

Conference Coordinators
Heather Stokes; Jennifer Stokes; Erlee Meyers

Welcome to the Tenth Annual Event

Akif Ündar, PhD

Penn State Hershey Pediatric Cardiovascular Research Center, Department of Pediatrics, Surgery and Bioengineering, Penn State Hershey College of Medicine, Penn State Hershey Children's Hospital, Hershey, PA, USA

I am honored to welcome you to the 10th International Conference on Pediatric Mechanical Circulatory Support Systems and Pediatric Cardiopulmonary Perfusion at the Hall of Flags, University of Pennsylvania, Philadelphia, PA, USA, May 28–31, 2014.

The overall objective of the conference has been and still is to bring together internationally known clinicians, bioengineers, and basic scientists involved in research on pediatric mechanical circulatory support (MCS) systems and pediatric cardiopulmonary bypass (CPB) procedures. Primarily, we focus on explicitly describing the problems with current pediatric MCS systems, methods, and techniques during acute and chronic support and suggesting solutions and future directions for research. Year after year, we have not only fulfilled our primary objective but also improved by adding several wet labs during which we have tried out cutting-edge new devices and conducted animal experiments (1,2).

There is no question that over the past decade, this unique event has become not only the recognized international forum at which to share the latest developments in terms of devices and techniques for pediatric CPB and MCS but also the place to start new national and international collaborations in this underserved population. More than 2250 leading international scholars from 33 countries have participated in the past nine events. However, it is the peerreviewed publications that have been the most significant products of these past events. Over 400 publications, including original articles, editorials, special reports, and case reports, have been peerreviewed and published in Artificial Organs. These publications have become the largest resource for investigators in research projects related to pediatric CPB and MCS.

Chitra Ravishankar, MD, is the local scientific chair of the 10th event. The co-chairs of the event are Tami Rosenthal, CCP, MBA (perfusion); Kerem Pekkan, PhD (bioengineering); Vinay M. Nadkarni, MD (extracorporeal cardiopulmonary resuscitation), Shigang Wang, MD; J. Brian Clark, MD; and John L. Myers, MD.

The scientific program of the 10th event will start on May 29, 2014, with a plenary session entitled "Pediatric MCS and Heart Transplantation: Current and Future Trends," followed by the first Keynote Lecture, entitled "Aortic Valve Surgery in Neonates, Infants, and Children: Has Anything Changed During My Career?," by Thomas L. Spray, MD, who is Chief of the Division of Cardiothoracic Surgery and Alice Langdon Warner Endowed Chair in Pediatric Cardiothoracic Surgery at The Children's Hospital of Philadelphia and Professor of Surgery at Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA, USA. Dr. Spray will be introduced by Stephanie Fuller, MD, also of the Children's Hospital of Philadelphia.

The program will continue in the afternoon with two more plenary sessions entitled "Minimizing Adverse Effects of CPB & ECLS: a Multidisciplinary Team Approach" and "ECPR & ECLS: Utilization, Management, and Outcomes."

Plenary Session 4, entitled "Engineering Approach to Pediatric Cardiovascular Medicine" and organized by Dr. Kerem Pekkan, will be held on the second day. It will include several national and international scholars with multidisciplinary backgrounds. The second Keynote Lecture, entitled "Individualized Strategy for HLHS: Norwood/Sano, Norwood/BT Shunt, or Hybrid?," will be introduced by Paul Chai, MD, of Columbia University Medical Center and presented by Emile Bacha, MD, FACS, who is Calvin F. Barber Professor of Surgery at Columbia University; Chief of the Division of Cardiac, Thoracic & Vascular Surgery at Columbia University Medical Center; and Director of Pediatric Cardiac Surgery at Morgan Stanley Children's Hospital and NewYork–Presbyterian Hospital, New York, NY, USA. The second day will continue with Plenary Session 5, entitled "VAD & ECLS," followed by several wet labs on the topic of "Hands-On Experience With the Newest Pediatric CPB/ECLS/MCS Systems." These 3-hour wet labs will be accompanied by parallel interactive training at the Children's Hospital of Philadelphia, entitled "ECLS Simulator Training at CHOP," with Roxanne Kirsch, MD; Stacie B. Peddy, MD; and

Roberta L. Hales, MHA, RRT-NPS, RN, serving as instructors. This program is for ICU physicians, cardiothoracic surgeons, nurses, perfusionists, and respiratory therapists involved in cannulation and management in extracorporeal membrane oxygenation (ECMO). The program will use simulation to facilitate hands-on training in extracorporeal cardiopulmonary resuscitation. In addition, this program focuses on techniques to train residents/fellows and nurses for a successful ECMO program as well as techniques to build a simulation program. The program will run twice in the afternoon, and each run will accommodate a maximum of 20 participants.

Sessions on "Cardiac ICU Rounds and Case Presentations at CHOP" will be held in the cardiac ICU (CICU) at the Children's Hospital of Philadelphia and led by CICU staff. Each session will be interactive, and active discussion from attendees will be invited regarding all aspects of management and outcomes. There will be two sessions, each of 90 minutes' duration, and space is restricted to 25 participants for each session. The session will be suitable for all staff involved in the management of critically ill children with heart disease and will include a tour of the unit and discussion regarding resources and staffing requirements.

The final day of the event will begin with the sixth plenary session, entitled "Pediatric Perfusion: 2014 Update," including national and international experts discussing the latest results in pediatric perfusion. The conference will end with a regular slide presentation session of slides selected from submitted abstracts. Ten regular slide presenters will cover the latest results of research on the pediatric MCS, CPB and extracorporeal life support procedures.

This unique event will continue to recognize young investigators, including medical and engineering graduate students, research assistants, and junior faculty members in all related disciplines. Young Investigator Awards will be awarded based on full manuscripts. In addition, a special travel award will be given to the investigator who travels the longest distance to attend the conference.

Further details regarding this event, including scientific program, Young Investigator Awards, and publications, can be accessed via the conference website at *http://pennstatehershey.org/web/pedscpb/home*.

Research findings reported during the past nine conferences have already made a significant impact on the treatment of pediatric cardiac patients worldwide. As we have written several times before, our motto continues to be "If the course of just one child's life is improved as a result of this event, we have reached our goal."

Once again, I am honored to welcome each of you to this unique event.

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Acknowledgments We thank Penn State Hershey Pediatric Cardiovascular Research Center, Penn State Hershey Children's Hospital, and the International Society for Pediatric Mechanical Cardiopulmonary Support for providing financial support to this event year after year. In addition, we received confirmations or funds from the following companies for the 10th event (as of March 1, 2014): Xenios Pediatrics (Heilbronn, Germany), Terumo Cardiovascular Systems (Ann Arbor, MI, USA), MAQUET Medical Systems (Wayne, NJ, USA), Syncardia Systems (Tucson, AZ, USA), COVIDIEN (Boulder, CO, USA) and Wiley- Blackwell (Hoboken, NJ, USA).

Special thanks go to Heather Stokes; Erlee Meyers, MBA; and Jennifer Stokes, RN, all from the Pediatric Clinical Research Office of Penn State Milton S. Hershey Medical Center, for their assistance in the coordination of this event.

We would specifically like to thank Dr. Shigang Wang of the Pediatric Cardiovascular Research Center at Penn State Hershey for organizing this event from start to finish. We also appreciate the invaluable help organizing continuing medical education provided by Ann Hagan from the Department of Continuing Medical Education of the Children's Hospital of Philadelphia.

During the past 10 years, as always, I have received unconditional support from my family: my wife, Pinar, and children, Damla and Akifcan.

This issue of Artificial Organs is dedicated to abstracts accepted for the conference. In addition, the January 2015 issue will be dedicated to our conference manuscripts (all peer-reviewed). Special thanks to Carol Malchesky, Editorial

Assistant; Angela T. Hadsell, Executive Editor; and Paul Malchesky, D. Eng, Editor-in-Chief, for making this issue and all previous issues possible and for their continued support year after year. This Wecome Letter was extracted from Dr. Ündar's earlier publication (3).

REFERENCES

1. Ündar A, Wang S, Palanzo D, et al. Outcomes of the Ninth International Conference on Pediatric Mechanical Circulatory Support Systems and Pediatric Cardiopulmonary Perfusion [guest editorial]. Artif Organs 2014;38:5–10.

2. Ündar A, Akçevin A, Alkan-Bozkaya T, et al. Outcomes of the Eighth International Conference on Pediatric Mechanical Circulatory Support Systems and Pediatric Cardiopulmonary Perfusion [guest editorial]. Artif Organs 2013;37:1–9.

3. Ündar A. Tenth International Conference on Pediatric Mechanical Circulatory Support Systems and Pediatric Cardiopulmonary Perfusion [guest editorial]. Artif Organs 2014;38(5). (in press)

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Final Scientific Program

WEDNESDAY, MAY 28, 2014

1:00 – 5:00pm **ON-SITE REGISTRATION (Only if Space is Available)**

THURSDAY, MAY 29, 2014

7:00 – 8:00am **Breakfast / Conference Registration**

8:00 – 8:15am **WELCOME**
Akif Ündar, PhD, Penn State Hershey Children's Hospital & Penn State Hershey College of Medicine, Hershey, PA, USA
Chitra Ravishankar, MD, (Local Chair), Children's Hospital of Philadelphia (CHOP), Philadelphia, PA, USA

8:15 - 10:00am **PLENARY SESSION #1:**

Pediatric MCS and Heart Transplantation: Current and Future Trends (20 min Each)

Moderators: William S. Pierce, MD, Hershey, PA, USA, *Joseph Rossano, MD, Philadelphia, PA, USA, and J. Brian Clark, MD, Hershey, PA, USA*

IL1. Diagnosis and Management of Myocarditis in Children
Matthew O'Connor, MD, Philadelphia, PA, USA

IL2. The Use of VAD Support in Children: the State of the Art
Christopher Mascio, MD, Philadelphia, PA, USA

IL3. Myths and Facts of Pulsatile Flow during Acute and Chronic MCS in Neonates and Infants
Akif Ündar, PhD, Hershey, PA, USA

IL4. Pediatric Cardiac Transplantation for Complex Congenital Heart Disease
Paul Chai, MD, New York, NY, USA

IL5. VADs and Outcomes Post Transplantation: What We Know and What We Don't Know?
Pirooz Eghtesady MD, PhD, St. Louis, MO, USA

10:00 - 10:45am **Coffee Break/Exhibits/Posters**

10:45 - Noon **Key Note Lecture #1:**

Aortic Valve Surgery in Neonates, Infants, and Children: Has Anything Changed during My Career?
***Thomas L. Spray, MD**, Chief, Division of Cardiothoracic Surgery, Alice Langdon Warner Endowed Chair in Pediatric Cardiothoracic Surgery, Professor of Surgery, Perelman School of Medicine at the University of Pennsylvania, The Children's Hospital of Philadelphia, Philadelphia, PA, USA*

Introduction: Stephanie Fuller, MD, Philadelphia, PA, USA

11:45am – Noon **Presentation of Young Investigators' Awards**

Noon - 1:00pm **Lunch Break**

1:00 - 3:00pm **PLENARY SESSION #2:**

Minimizing Adverse Effects of CPB: a Multi-disciplinary Team Approach (20 min Each)

Moderators: Paul Chai, MD, New York, NY, USA, Pirooz Eghtesady MD, PhD, St. Louis, MO, USA and Talya Frey, CCP, Philadelphia, PA, USA

IL6. Anesthesiologist' Perspective
Aruna Nathan, MD, Philadelphia, PA, USA

IL7. Surgeon's Perspective
Emre Belli, MD, Le Plessis Robinson, France

IL8. Perfusionist's Perspective
David Palanzo, CCP, Hershey, PA, USA

IL9. Cardiac Intensivist's Perspective
Roxanne Kirsch MD, Philadelphia, PA, USA

IL10. Apolipoprotein E Levels in Pediatric Patients Undergoing Cardiopulmonary Bypass
Mehmet Âğırbaşlı, MD, Istanbul, Turkey

IL11. Alternative Transcatheter Procedures to Surgery in the Treatment of Congenital Heart Disease
Ender Ödemiş, MD, Istanbul, Turkey

3:00 - 3:45am **Coffee Break/Exhibits/Posters/Wet-Labs**

3:45 - 5:45pm **PLENARY SESSION #3:**

ECPR & ECLS: Utilization, Management, and Outcomes (20 min Each)

Moderators: Vinay M. Nadkarni, MD, Philadelphia, PA, USA, Stephanie Fuller, MD, Philadelphia, PA, USA and Ravi Thiagarajan, MD, Boston, MA, USA

IL12. The Utilization of ECPR in the Pediatric Population
Javier Lasa, MD, Philadelphia, PA, USA

IL13. Outcomes of ECPR for Cardiac Indications
Maryam Naim, MD, Philadelphia, PA, USA

IL14. Role of Post Arrest Management and Neuromonitoring in Improving Outcomes
Alexis Topjian, MD, Philadelphia, PA, USA

IL15. Novel Diagonal ECLS System Improves Outcomes in Pediatric Cardiac Patients
Sertaç Haydin, MD, Istanbul, Turkey

IL16. Long-term Outcome and Quality of Life after ECLS
Ravi Thiagarajan, MD, Boston, MA, USA

IL17. Impact of the Recent Influenza Season on ECMO Programs
David Palanzo, CCP, Hershey, PA, USA

FRIDAY, MAY 30, 2014

7:00 – 8:00 am **Breakfast / Conference registration**

8:00 – 10:00am **PLENARY SESSION #4:**

Engineering Approach to Pediatric Cardiovascular Medicine (20 min Each)

Moderators: Kerem Pekkan, PhD, Pittsburgh, PA, USA and Giovanni Battista Luciani, MD, Verona, Italy

IL18. An Intravascular Therapeutic Device for Pediatric Patients with Congenital Heart Disease: Mechanical Support of the Fontan Physiology
Amy Throckmorton, PhD, Philadelphia, PA, USA

IL19. Functionalized Tissue Engineered Patches for Pediatric Surgical Reconstructions
Brad Keller, MD, Louisville, KY, USA,

IL20. Translating Technology into Clinical Practice: a Brazilian Pediatric Ventricular Assist Device Development
Idágene Cestari, PhD, Sao Paolo, Brazil

IL21. Advances in Heart Valve Bioengineering with Special Emphasis on Scaling
Lakshmi P. Dasi, PhD, Denver, CO, USA

IL22. Computational Fluid Dynamics in Congenital Aortic Valve Disease
Giovanni Battista Luciani, MD, Verona, Italy

IL23. Progress in Computational Modeling of Neonatal Cardiopulmonary Bypass Hemodynamics with Detailed Circle of Willis Anatomy
Kerem Pekkan, PhD, Pittsburgh, PA, USA

10:00 – 11:00am **Coffee Break/Exhibits/Posters**

11:00 – Noon **Key Note Lecture #2**

Individualized Strategy for HLHS: Norwood/Sano, Norwood/BT Shunt or Hybrid?

Emile Bacha, MD, FACS, *Calvin F. Barber Professor of Surgery, Chief, Division of Cardiothoracic Surgery, New York-Presbyterian/Columbia University Medical Center, Director, Pediatric Cardiac Surgery, Morgan Stanley Children's Hospital, New York, NY, USA*

Introduction: Paul J. Chai, MD, New York, NY, USA

Noon – 1:00pm **Lunch Break**

1:00 – 3:00pm **PARALLEL SESSIONS**

1:00 - 3: 00pm **PLENARY SESSION #5:**

VAD & ECLS (20 min Each)

Moderators: Atıf Akçevin, MD, Istanbul, Turkey and Emre Belli, MD, Paris, France

IL24. Is It Time to Go Back to Pulsatile Flow: Consequences of Non-Pulsatile and Pulsatile Flow in Cardiopulmonary Bypass and Mechanical Circulatory Support Devices?
Jack G. Copeland, MD, San Diego, CA, USA

IL25. Rehabilitation after VAD: Role of Ancillary Staff
Rebecca Hoffritz, PT, DPT, Meghan Burkhardt, MS, OTR (L), Meredith McDonaugh, MS, CCLS IV, Philadelphia, PA, USA

IL26. Extracorporeal Life Support for Low Flow Applications ECLS Set 2.8 - First Standardized Solution
Thomas Markmann, MBA, Rastatt, Germany

IL27. Cost Effective Usage of Hollow Fiber Membrane Oxygenators in Extracorporeal Membrane Oxygenation in Infants
Atıf Akçevin, MD, Istanbul, Turkey

IL28. Extracorporeal Circulation: Ten-year Practices in China
Wei Wang, MD, PhD, Shanghai, China

Slide Presentation (selected from Abstracts)

S1. Monitoring Cerebral and Somatic NIRS Values (Renal and Hepatic) during Cardiac Surgery in Neonates and Infants
Tijen Alkan-Bozkaya[1], Tuğrul Örmeci[2], Cihangir Ersoy[1], Arda Özyüksel[1], Burak Arkan[1], Akif Ündar[3]. Atıf Akçevin[1], Halil Türkoğlu[1], Istanbul Medipol University, Dept. of Cardiovascular Surgery[1] and Radiology[2], Istanbul, TURKEY, and Penn State University, Children's Hospital, Hershey, PA, USA[3]

3:00pm – 3:30pm **Coffee Break/Exhibits/Posters/Wet-Labs**

3:45 – 6:45pm	**WET-LABS**
	Moderators: Talya Frey, CCP, Philadelphia, PA, USA, David Palanzo, CCP, Hershey, PA, USA and Akif Ündar, PhD, Hershey, PA, USA
	Hands-On Experience with the Newest Pediatric CPB/ECLS/MCS Systems
	Six wet-labs (30 min each)
1:00 – 5:30pm	**PARALLEL SESSIONS**
1:00 - 5:30pm	**ECLS Simulation & Cardiac ICU Rounds and Case Presentations:**
	(Advanced Registration is Required)
	Instructors: Roxanne Kirsch MD, Philadelphia, PA, USA, Stacie B. Peddy, MD, Philadelphia, PA, USA and Roberta L. Hales MHA, RRT-NPS, RN
1:15- 3:00pm	**Group #1:** **CICU Rounds (Advanced Registration is Required)**
	Group #2: **ECLS Simulation (Advanced Registration is Required)**
3:00 – 3:30pm	**Coffee Break/Exhibits/Posters/Wet-Labs**
3:30 - 5:30pm	**Group# 3:**
	CICU Rounds (Advanced Registration is Required)
	Group #4:
	ECLS Simulation (Advanced Registration is Required)
	ECLS Simulator Training:
	This session is for ICU physicians, CT surgeons, nurses, perfusionists and respiratory therapists involved in ECMO cannulation and management. The session will use simulation to facilitate ECPR hands on training. In addition, this program focuses on techniques to train residents/fellows and nurses for a successful ECMO program as well as techniques to build a simulation program. This program will run twice in the afternoon, and each session will incorporate a maximum of 20/session.
	Cardiac ICU Rounds and Case Presentations:
	These sessions will be held in the CICU at The Children's Hospital of Philadelphia and lead by CICU staff. Each session will be interactive during which active discussion from attendees is invited regarding all aspects of management and outcomes. There will be 2 sessions, each of 90 minutes duration, and space is restricted to 25 participants for each session. The session will be suitable for all staff involved in the management of critically ill children with heart disease and will include a tour of the unit and discussion regarding resources and staffing requirements.

SATURDAY, MAY 31, 2014

8:00 – 10:00am **PLENARY SESSION #6:**

Pediatric Perfusion: 2014 Update (20 min Each)

Moderators: Haydon Dando, CCP, Sydney, Australia, Talya Frey, CCP, Philadelphia, PA, USA, and Wei Wang, MD, PhD, Shanghai, China

IL29. Evaluation of Commercially Available Neonatal & Pediatric ECLS Systems
Akif Ündar, PhD, Hershey, PA, USA

IL30. EVLP: How Our Institution Performs
Gregg Roach, CCP, Philadelphia, PA, USA

IL31. Use of Blood Products in Pediatric Cardiac Surgery
Yves Durandy, MD, Le Plessis Robinson, France

IL32. Evaluation of Different Diameter Arterial Tubing and Arterial Cannulae in Simulated Pediatric CPB Circuits
Shigang Wang, MD, Hershey, PA, USA

IL33. Developing a Culture of Safety
Talya Frey, CCP, Philadelphia, PA, USA

10:00 – 10:45am **Coffee Break/Exhibits/Posters/Wet-Labs**

10:45 – 1:00pm **REGULAR SLIDE PRESENTATIONS:**

Pediatric MCS, ECLS and CPB (Selected from Abstracts)
Moderators: Yves Durandy, MD, Le Plessis Robinson, France, Wei Wang, MD, PhD, Shanghai, China and Linda Pauliks, MD, MPH, USA

S2. Total Artificial Heart Bridge to Transplantation in Pediatric Patients, a 10 Year Follow-up in 3 Patients
Hannah Copeland, Richard G Smith, Francisco Arabia, Jack G Copeland. Loma Linda University, Loma Linda, CA USA

S3. Pediatric Centrifugal Assist Devices in a Developing Country: An Efficient and Economical Option to Treatment the Postcardiotomy Heart Failure - Institutional Experience
[,‡]James Parada, MD, [‡]Antonio Benita, MD, [‡]Jorge Cervantes, MD and [‡]Samuel Ramírez, MD. [‡]Department of Pediatric Cardiac Surgery and Congenital Heart Malformations. National Institute of Cardiology Ignacio Chavez, Mexico City*

S4. Interhospital Transport with Extracorporeal Life Support in Pediatric Patients
Jeng-Wei Chen, Yih-Sharng Chen, Nai-Hsin Chi, Chih-Hsien Wang, Shu-Chien Huang. Cardiac Surgical Division, Surgical Department, National Taiwan University Hospital, Taipei, Taiwan

S5. Determination of a New Mutation in MT-ND1 gene of a Patient with Dextrocardia, Ventriculoarterial Discordance and Tricuspid Atresia
Ali Can Hatemi[1,2], Aris Çakiris[3], Aybala Tongut[2], Hakan Ceyran[2], Duran Üstek[3]. [1]Istanbul University, Institute of Cardiology, Department of Cardiovascular Surgery, [2]Kartal Kosuyolu Education and Research Hospital, Department of Cardiovascular Surgery, Division of Pediatric Cardiovascular Surgery, [3]Istanbul University, Institute for Experimental Medical Research, Department of Molecular Genetics, Istanbul, Turkey

S6. Cardiopulmonary Bypass Priming Using Autologous Cord Blood in Neonates with Congenital Heart Disease
Eun Seok Choi, MD, Woong-Han Kim, MD, Sungkyu Cho, MD, Woo Sung Jang, MD. Department of Thoracic and Cardiovascular Surgery, Seoul National University Children's Hospital, Seoul National University College of Medicine, Seoul, Korea

S7. A CPB Circuit and Protocol for Comparing Continuous and Pulsatile CPB in a Single Animal
[†]Ryan Halter, PhD, [†‡]Karen Moodie, DVM, [†‡]Joseph DeSimone, MD, and [‡]Mark Farrell. [*]Thayer School of Engineering, [†]Geisel School of Medicine, Dartmouth College, Hanover, NH, USA; and [‡]Dartmouth-Hitchcock Medical Center, Lebanon, NH, USA*

S8. Myocardial Histology of Neonatal Piglets after Cardioplegic Protected Cardiac Arrest on Cardiopulmonary Bypass
Tirilomis T, Bensch M, Waldmann-Beushausen R, Schoendube FA. Dept. for Thoracic, Cardiac, and Vascular Surgery, University of Goettingen, Goettingen, Germany

S9. Blood-Surface Interaction and Aggregation of Serum Proteins during Extracorporeal Circulation with Phosphorylcholine-Coated Tubing Lines: S100A8/A9 is it the Trigger for Inflammation?
Ali Can Hatemi[1], Aris Çakiris[2], Kadir Çeviker[1], Neslihan Abacı[2], Fulya Coşan[2], Öznur Ağlar[2], Hülya Azakli[2], Zeliha Ökten[2], Erhan Kansız[1], Duran Üstek[2]. [1]Istanbul University, Institute of Cardiology, Department of Cardiovascular Surgery, [2]Istanbul University, Institute for Experimental Medical Research, Department of Molecular Genetics, Istanbul, Turkey

THURSDAY 8:00am - SATURDAY 1:00pm

REGULAR POSTER PRESENTATIONS:

Moderators: Tijen Alkan-Bozkaya, MD, Istanbul, Turkey and Shigang Wang, MD, Hershey, PA, USA

P1. Use of a Novel Diagonal Pump in an In Vitro Neonatal Pulsatile Extracorporeal Life Support Circuit
[*]Alissa Evenson, [*]Shigang Wang, [†]Allen R. Kunselman, and [‡§]Akif Ündar. [*]Pediatric Cardiovascular Research Center, Department of Pediatrics,*

[†]Public Health Sciences, [‡]Surgery, Penn State Milton S. Hershey Medical Center, Penn State Hershey College of Medicine, Hershey, PA; and [§]Bioengineering, College of Engineering, Pennsylvania State University, University Park, PA, USA

P2. Weaning Strategy in Pediatric Extracorporeal Support for Lung Disease

Jeng-Wei Chen, Yih-Sharng Chen, Nai-Hsin Chi, Chih-Hsien Wang, Shu-Chien Huang. Cardiac Surgical Division, Surgical Department, National Taiwan University Hospital, Taipei, Taiwan

P3. Surgical Approach to Aorticopulmonary Window Accompanied by Interrupted Aortic Arch in Newborns

Cihangir Ersoy[1], Tijen Alkan-Bozkaya[1], Arda Özyüksel[1], Atıf Akçevin[1], Halil Türkoğlu[1], Vedat Bayer[2], Tufan Paker[2]. Istanbul Medipol University, Dept. of Cardiovascular Surgery[1] and VKV, American Hospital, Dept. of Cardiovascular Surgery[2], Istanbul, TURKEY

P4. Evaluation of Four Pediatric Cardiopulmonary Bypass Circuits in Terms of Perfusion Quality and Capturing Gaseous Microemboli

Ryan K. Mathis[1], Judith Lin[1], Natalie M. Dogal[1], Feng Qiu[1], Allen R. Kunselman[2], Shigang Wang[1] and Akif Ündar[1,3]. Pediatric Cardiovascular Research Center, Departments of Pediatrics[1], Public Health and Sciences[2], Surgery and Bioengineering[3], Penn State College of Medicine, Penn State Children's Hospital, Hershey, Pennsylvania, USA

P5. Is It Important the Cerebral NIRS Monitoring during Pediatric Aortic Coarctation and/or Arch Repair?

Tijen Alkan-Bozkaya, Atıf Akçevin, Halil Türkoğlu, Cihangir Ersoy. Istanbul Medipol University, Dept. of Cardiovascular Surgery, Istanbul, TURKEY

P6. Is There a Difference Between Pulsatile and Nonpulsatile Perfusion Mode According to Cyanotic or Not as Perioperative Parameters in Pediatric Cardiac Surgery with CPB?

Yeliz Koçoğlu[1,2] , Atıl Gürsoy[1,3] , Tijen Alkan-Bozkaya[1], Halil Türkoğlu[1], Atıf Akçevin[1]. [1]Istanbul Medipol University, Graduate School of Health Sciences, Dept. of Cardiovascular Surgery, Istanbul, TURKEY, [2]Marmara University, Pendik Education and Research Hospital, Dept. of Cardiovascular Surgery, [3]Sakarya Ada Medicine, Dept. of Cardiovascular Surgery, Turkey

P7. Novel Pulsatile ECLS System with Superior Hemodynamic Energy

Shigang Wang[1], Sunil Patel[2], Allen R. Kunselman[3], and Akif Ündar[1,4,5] [1]Pediatric Cardiovascular Research Center, [2]Pediatric Cardiology Division, Department of Pediatrics, [3]Public Health Sciences, [4]Surgery, Penn State Milton S. Hershey Medical Center, Penn State Hershey College of Medicine, Hershey, PA; and [5]Bioengineering, College of Engineering, Pennsylvania State University, University Park, PA, USA

P8. Hemodynamic Evaluation of Novel i-cor® Pulsatile MCS System during Various Cardiac Arrhythmias: In Vitro Pilot Study

[£]Sunil Patel, [*]Shigang Wang, [£]Dennis Chang, [*]Linda B Pauliks, MD, MPH1, [‡]J. Brian Clark, MD, [†]Allen R. Kunselman, and [*‡§]Akif Ündar. [*]Pediatric Cardiovascular Research Center, Department of Pediatrics, [£]Pediatric Cardiology Division, [†]Public Health Sciences, [‡]Surgery, Penn State Milton S. Hershey Medical Center, Penn State Hershey College of Medicine, Hershey, PA; and §Bioengineering, College of Engineering, Pennsylvania State University, University Park, PA, USA*

P9. Perioperative Cerebral and Renal Perfusion Monitoring with NIRS in Pediatric Patients Undergoing Cardiac Surgery

Arda Özyüksel[1], Tijen Alkan-Bozkaya[1], Pelin Karaaslan[2], Cihangir Ersoy[1], Tuğrul Örmeci[3], Burak Arkan[1], Atıf Akçevin[1], Halil Türkoğlu[1]. Istanbul Medipol University, Dept. of Cardiovascular Surgery[1], Anestesiology[2] and Radiology[3], Istanbul, TURKEY

P10. Comparative Effects of Pulsatile and Nonpulsatile Flow on Plasma Fibrinolytic Balance in Pediatric Patients Undergoing Cardiopulmonary Bypass

Mehmet A. Aĝirbaşli[1], Jianxun Song[2], Fengyang Lei[2], Shigang Wang[3], Allen R. Kunselman[4], Joseph B. Clark[3,5], John L. Myers[3,5], and Akif Ündar[3,5,6]. [1]Department of Cardiology, College of Medicine, Istanbul, Turkey; [2]Department of Microbiology and Immunology; [3]Pediatric Cardiovascular Research Center, Department of Pediatrics, [4]Public Health Sciences, [5]Surgery, and [6]Bioengineering, Penn State College of Medicine, Penn State Children's Hospital, Hershey, Pennsylvania, USA

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Keynote Lecture 2. Individualized Strategy for HLHS: Norwood/Sano, Norwood/BT Shunt or Hybrid?

Emile Bacha, MD, FACS

Calvin F. Barber Professor of Surgery, Chief, Division of Cardiothoracic Surgery, New York-Presbyterian/Columbia University Medical Center, Director, Pediatric Cardiac Surgery, Morgan Stanley Children's Hospital, New York, NY, USA

Abstract:

Over the past decade, new variations on the "classic" first stage palliation (the Norwood/BT shunt) for patients with Hypoplastic Left Heart Syndrome have emerged and been vetted by the medical community. A "one size fits all" approach may not be adequate anymore.

In this review, the optimal indications for the various palliative options (Norwood/BT shunt, Norwood/RV-PA conduit, Hybrid Stage I with or without ductal stenting, heart transplantation) are reviewed from a standpoint of the initial anatomy and physiology of the patient, letting it guide clinical management. Current knowledge useful for decision-making is also reviewed as objectively as possible.

IL1. Diagnosis and Management of Myocarditis in Children

Matthew J. O'Connor, MD

Division of Cardiology, The Children's Hospital of Philadelphia, Philadelphia, PA, USA

Objective:

To review current diagnostic testing available for myocarditis in children; to review the differential diagnosis of myocarditis in children; to review current management strategies for myocarditis in children, with a focus on recent developments in this area; and to briefly review the outcomes of myocarditis in children, again with a focus on recent outcome data in children.

Methods:

The scientific literature related to the diagnosis and management of myocarditis in children will be reviewed to select the most pertinent information. Although general diagnostic and management concepts will be discussed, attention will be paid to recently published studies.

Results:

Myocarditis is an uncommon diagnosis in children, but is seen frequently in previously healthy children presenting with symptomatic ventricular dysfunction. The diagnosis is largely made on the basis of clinical, laboratory, and echocardiographic findings, but cardiac MRI is assuming a greater role in the diagnosis in some centers. Cardiac catheterization with endomyocardial biopsy is utilized when the diagnosis remains uncertain. Myocarditis is generally treated supportively, with severe cases frequently needing mechanical circulatory support. The prognosis is variable and depends on a number of factors such as age, severity of clinical presentation, and the etiology.

Conclusions:

Myocarditis in children has many possible etiologies; however, most cases are treated similarly with mechanical support frequently employed as a short-term method of assisting the circulation. Cardiac MRI is assuming a greater role in the diagnosis. Outcomes are variable and depend on a number of complex factors.

IL2. The Use of VAD Support in Children: the State of the Art

Christopher E. Mascio

Pediatric Cardiothoracic Surgery, Department of Surgery, The Children's Hospital of Philadelphia, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA

Abstract:

The first implantation of a ventricular assist device (**VAD**) was done in 1963 in an adult. Pediatric VADs were made available in North America in 2000 and implantation of these devices as bridge to transplant significantly increased with widespread use of the Berlin Heart EXCOR device. Because both neonatal and infant cardiac surgical survival and pediatric admissions for heart failure have increased, the need for pediatric mechanical support as a bridge to recovery or transplant is expected to continue.

An initial step is to determine the type of support necessary. Patients arresting or requiring cardiopulmonary support are supported with extracorporeal membrane oxygenation (**ECMO**). Once there is pulmonary recovery in those on ECMO; and, for patients only requiring cardiac support there are short-term (<2 weeks) support options and long-term (>2 weeks) support options. Timing of implantation - awaiting end organ recovery or proceeding to prevent worsening of end organ function - is critical.

Short-term options include the RotaFlow, PediMag, and Tandem Heart. All three are continuous flow, extracorporeal devices. None permit ambulation and the Tandem Heart is placed percutaneously and is used in larger patients (>40 kg, BSA >1.3). Long term-options include the Berlin Heart EXCOR, Thoratec PVAD/IVAD, SynCardia Total Artificial Heart, HeartWare HVAD, and the HeartMate II. The Berlin Heart is the only long-term FDA approved VAD for neonates and infants. It has five different pump sizes and can support older children/adolescents also. The Total Artificial Heart eliminates concern over residual anatomic lesions that present challenges with the use of other devices. The HeartWare device is very small and is implanted in the pericardial space. The HeartMate II is the most common VAD used in adults and is appropriate for some adolescents.

There are perioperative concerns in caring for this patient population that affect the entire team – anesthesiology, surgery, and intensive care. Proper management of right heart failure can prevent the need for biventricular support. Cannulation sites are important for optimal filling and function of the device. Bleeding, stroke and infection are postoperative concerns with all devices.

Pediatric mechanical support continues to evolve. Outcomes are expected to improve with advances in perioperative management and device design.

IL3. Myths and Truths of Pulsatile and Nonpulsatile Perfusion during Acute and Chronic Cardiac Support

Akif Ündar[1,2,3], Shigang Wang[1], David Palanzo[4], Feng Qiu[1], Tijen Alkan-Bozkaya[5], Atıf Akçevin[5], Mehmet A. Ağirbaşli[6], Larry Baer[4], Karl Woitas[4], Robert Wise[4], Robert McCoach[4], Yulong Guan[7], Nikkole M. Haines[1], Joseph B. Clark[2], John L. Myers[2]

Penn State Hershey Pediatric Cardiovascular Research Center, Departments of Pediatrics[1], Surgery[2], Bioengineering[3], Heart and Vascular Institute[4], Penn State Hershey College of Medicine, Penn State Hershey Children's Hospital, Hershey, Pennsylvania, US; Department of Cardiovascular Surgery, American Hospital, Istanbul, Turkey[5]; Department of Cardiology, College of Medicine, Istanbul, Turkey[6]; Department of Cardiopulmonary Bypass, The Fuwai Hospital, Beijing, China[7]

Myths and truths of perfusion modes during acute and chronic mechanical circulatory support are summarized in Table 1 and Table 2, respectively (1).

Table 1. Myths and truths of pulsatile perfusion during cardiopulmonary bypass (CPB).

Myths	Truths
Pulse pressure is adequate for precise quantification of different perfusion modes or different types of pulsatile perfusion.	Generation of pulsatile flow depends on energy gradient rather than a pressure gradient. The energy equivalent pressure formula is the best tool to quantify pressure-flow waveforms because it contains both pressure and pump flow waveforms.
If the pulse pressures are similar between two pulsatile systems, then the hemodynamic energy levels are also similar.	With the identical pulse pressures, a physiologic pulsatile pump generates about 100% more hemodynamic energy than a pulsatile roller pump because of the physiologic morphology (shape and size) of the pressure-flow waveforms.
All pulsatile roller pumps generate adequate hemodynamic energy compared to nonpulsatile roller pumps.	Some pulsatile roller pumps do not generate any more hemodynamic energy when compared to a nonpulsatile roller pump. Therefore, the quantification of pressure flow waveforms is a must, not an option.
Membrane oxygenators are not important in producing the pulsatile pressure-flow waveforms.	Hollow-fiber membrane oxygenators are better than flat sheet type membrane oxygenators but the structure of hollow fibers is also an important factor. Pressure-drops caused by oxygenators must be compared. A lower pressure drop equals better pulsatility.
An aortic cannula has no impact on pulsatility.	Geometry of the aortic cannula has a direct impact on the quality of the pulsatility. The shorter the tip of the cannula, the better the pulsatility.
There is no difference in vital organ blood flow between perfusion modes.	Cerebral, renal, and myocardial blood flows recover significantly better with pulsatile perfusion.
There is no difference in systemic inflammation between perfusion modes.	Pulsatile perfusion reduces the endothelial damage and suppresses the activation of complements, neutrophils, and the production of cytokines.
Duration of support is not important during pulsatile perfusion. Even if pulsatile flow is used for only a few minutes, it is possible to see the benefits immediately.	If the duration of aortic cross-clamping exceeds 45 min, and only pulsatile flow is used, then it is possible to see the benefits. If pulsatile flow is used for 15 min out of 90 min of CPB, then it is not possible to see any difference in vital organ recovery between perfusion modes.
There is no difference in morbidity and mortality between perfusion modes.	If adequate pulsatility is achieved, patients do better with pulsatile perfusion. In particular, high-risk patients benefit from pulsatile perfusion more than low-risk patients.

Myths (Cont.)	Truths (Cont.)
Pulsatile flow prevents morbidity and mortality compared to the conventional nonpulsatile perfusion.	Pulsatile perfusion only minimizes the morbidity and mortality; it does not eliminate the adverse effects of CPB.
Pulsatile flow produces more circuit pressure and hemolysis compared to the nonpulsatile perfusion.	Circuit pressures and blood trauma are similar in both systems.
If there is a problem during pulsatile CPB, there is no way to change the perfusion mode.	It takes less than 3 s to change the perfusion mode from pulsatile to nonpulsatile or vice versa.
Institutional Review Board (IRB) approval is required to use pulsatile flow during CPB.	IRB approval is not required to use pulsatile flow.
Significant cost is associated with the pulsatile pumps.	The same pump systems are used for pulsatile and nonpulsatile perfusion. There is absolutely no extra cost.

Table 2. Myths and truths of pulsatile perfusion during chronic cardiac support.

Myths	Truths
Pulse pressure is adequate for precise quantification of different perfusion modes during chronic mechanical circulatory support.	If both pressure and pump flow waveforms are available, then the energy equivalent pressure formula should be used, otherwise the use of pulse power index, and/or pulsatility index is recommended.
Nonpulsatile perfusion does not have any negative effects on capillary perfusion during chronic support, because pulsatility does not exist in capillaries.	Pulsatility does exist in capillaries. Pulsatile flow significantly improves the velocity of erythrocytes in the capillaries and increases the number of perfused capillaries.
Nonpulsatile VADs (axial flow or centrifugal) produce 100% nonpulsatile pressure-flow waveforms.	Although the pump flow is 100% nonpulsatile, arterial waveforms have some degree of pulsatility because the natural heart is also pumping. If the patient's heart recovers well, then it is possible to achieve near physiologic arterial pressure waveforms.
Nonpulsatile and pulsatile VADs generate the same degree of systemic inflammation.	It is shown that a pulsatile VAD causes less systemic inflammation when compared to an axial flow pump.

Reference:

1. Undar A. Myths and truths of pulsatile and nonpulsatile perfusion during acute and chronic cardiac support. Artif Organs. 2004 May;28(5):439-43.

IL5. VADs and Outcomes Post Transplantation: What We Know and What We Don't Know?

Pirooz Eghtesady, MD, PhD

Div. of Cardiothoracic Surgery, St. Louis Children's Hospital, St. Louis, MO, USA

Abstract:

Increasingly, ventricular assist devices (**VAD**) are being used in children as a bridge to transplantation because of improved wait-list survival outcomes. Less is known about the impact of device therapy on outcomes post transplantation.

With the application of some of the adult devices, bridge to decision is also now being increasingly used as part of the decision algorithm for pediatric patients that may or may not be candidates for heart transplantation. The technology has also brought forth reconsideration of prior contraindications (e.g., elevated pulmonary vascular resistance) as well as discussions regarding implications on outcomes following transplantation (e.g., impact on sensitization and risk of rejection). Lastly, success with bridging patients has resulted in some major challenges or questions (e.g., Should a patient with renal failure or multiple organ dysfunctions be resuscitated or considered a candidate? What degree of neurologic injury while on support is inconsistent with continued listing? Etc.) to be raised for pediatric patients previously not encountered.

The presentation will discuss these issues and results from ongoing investigations related to EXCOR Berlin Heart application as well as the newer devices (e.g., HeartWare HVAD), in their off-label application, as they related to VAD therapy and post-transplant outcomes.

IL10. Apolipoprotein E Levels in Pediatric Patients Undergoing Cardiopulmonary Bypass

Mehmet A. Ağirbaşli[1], Jianxun Song[2], Fengyang Lei[2], Shigang Wang[3], Allen R. Kunselman[4], Joseph B. Clark[3,5], John L. Myers[3,5], and Akif Ündar[3,5,6]

[1]Department of Cardiology, College of Medicine, Istanbul, Turkey; [2]Department of Microbiology and Immunology; [3]Pediatric Cardiovascular Research Center, Department of Pediatrics, [4]Public Health Sciences, [5]Surgery, and [6]Bioengineering, Penn State College of Medicine, Penn State Children's Hospital, Hershey, Pennsylvania, USA

Objective: Apolipoprotein E (**apoE**) plays a critical role in modulating the response to neurological injury after stress. Therefore, apoE level may prove to be an important biomarker in the pathophysiology of cerebral injury after cardiopulmonary bypass (**CPB**) in children. The objectives of our study was a) to determine the variation of apoE levels after CPB in children, b) to compare the effects of different modes of CPB (pulsatile versus nonpulsatile) on apoE levels after CPB.

Methods: After Institutional Review Board approval, plasma samples were collected from 40 pediatric patients who underwent heart surgery. Study population was divided into 2 groups based on the mode of CPB. Half of the patients received non-pulsatile flow and the other half underwent pulsatile flow during CPB. Plasma samples were collected at three time points: 1. at baseline prior to surgery (after the arterial line is connected but prior to incision (T1), 2. one hour after CPB (T2), 3. twenty four hours after CPB (T3).

Results: ApoE levels increased significantly at 24 hours after CPB in both groups, and non-pulsatile mode was associated with significantly higher apoE levels at time points T1 (baseline) and T3 (24 hour after CPB) (**Figure 1**). As the distribution of the apoE levels were skewed, a logarithmic transformation was applied for comparison of apoE levels between the 2 groups. For the time point T1: ratio of geometric means was 0.70; 95% CI: (0.52, 0.95); p=0.02, T2: 0.89; 95% CI: (0.63, 1.25); p=0.49, and T3: 0.70; 95% CI: (0.53, 0.93); p=0.02.

Conclusions:

Our observations indicate that apoE levels increase significantly following CPB and mode of CPB may affect apoE levels after CPB. An improved understanding of these mechanisms, as well as the translation of such knowledge into the development of new techniques may improve the clinical outcome after CPB.

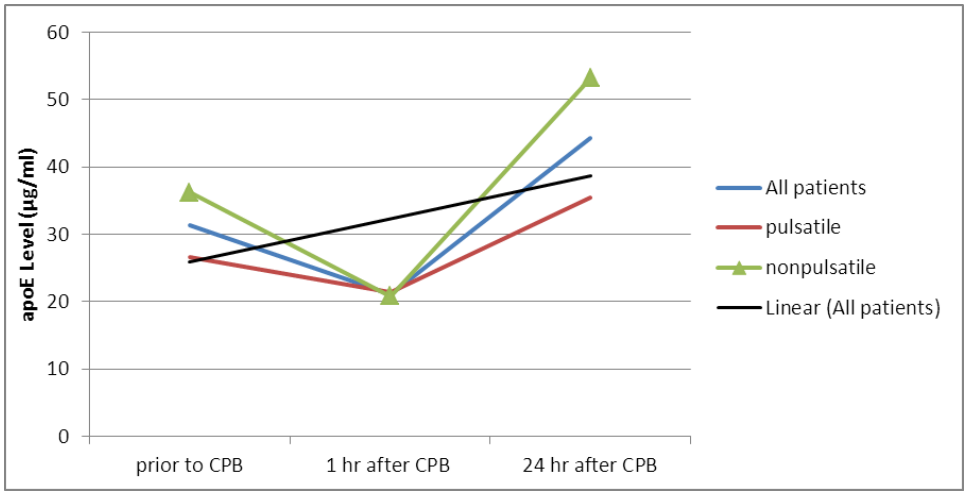

Figure 1. Apolipoprotein E levels at different time points following CPB in children.

IL11. Alternative Transcatheter Procedures to Surgery in the Treatment of Congenital Heart Disease

Ender Odemis

Department of Pediatric Cardiology, Istanbul Mehmet Akif Ersoy Hospital, Istanbul, TURKEY

Abstract:

Surgical techniques, cardiopulmonary bypass strategies and intensive care modalities improved since last decades in the treatment of congenital heart disease (CHD). However mortality and morbidity are still a concern in patients with high risk groups such as neonates, reoperations, necessity of long cardiopulmonary bypass etc.

In the other hand, transcatheter management of CHD has been a widely accepted policy. Since the last quarter of 20th century starting with balloon valvuloplasty of pulmonary valve now reached to percutaneous pulmonary valve implantation stage. Transcatheter closure of septal defects and patent ductus arteriosus are accepted first choice in selected cases. Many sort of percutaneous interventions in neonates including perforation of atretic valves, and stenting of ductus arteriosus are also alternative to surgery in order to prevent the children from undesired effects of cardiopulmonary bypass.

Finally as a proof of surgery and intervention relationship; in increasing number of hybrid procedures have been performing all over world.

IL12. The Utilization of ECPR in the Pediatric Population

Javier J. Lasa

Division of Anesthesiology and Critical Care Medicine, Children's Hospital of Philadelphia, University of Pennsylvania School of Medicine, Philadelphia, PA, USA

Abstract:

The evolution of extracorporeal cardiopulmonary resuscitation (ECPR) from its origins in cardiopulmonary bypass (CPB) to the current functionality beyond the operating theatre suggests new and exciting frontiers for extracorporeal support.

Implementing an effective ECPR program in the pediatric population requires a substantial commitment of both financial and personnel resources directed in a singular effort to rescue patients from failed conventional CPR. In addition, this effort requires a multidisciplinary team approach with skilled personnel that include perfusion specialists, general/cardiac surgeons, respiratory therapists, and critical care nurses and physicians. Yet limitations in resource allocation and patient selection bias remain obstacles to further progress. Additional challenges include our limited understanding of center specific variables, such as volume of cases, and their impact on outcomes.

During this presentation, ECPR utilization will be explored while exploring its origins and trajectory over the past 30 years.

IL15. Novel Diagonal ECLS System Improves Outcomes in Pediatric Cardiac Patients

[1]Sertac Haydin, [1]Okan Yıldız, [1]İ.Selen Onan, [1]Firat Altın, [2]Erkut Öztürk, [1]Mehmet Yeniterzi, [1]İhsan Bakır

[1] Department of Pediatric Cardiovascular Surgery, [2] Department of Pediatric Cardiology, İstanbul Mehmet Akif Ersoy Cardiothoracic Surgery Education and Research Hospital, İstanbul, Turkey

Objective:

The new Medos Deltastream DP3 system includes a diagonal pump and a hollow membrane oxygenator that provides pediatric extracorporeal life support (ECLS). DP3 has been used in Europe and also has different modes including pulsatility. Our ECLS system has been switched from Medos Deltastream DP2 to DP3 since November, 2012. The aim of this study is to investigate the efficiency of this new system.

Methods:

Between March 2011 and February 2014, the Medos Deltastream ECLS system was used in 55 patients. The system was DP2 in 25 patients before November 2012 and DP3 in 30 patients since then. The mean age was 15.6 months and mean ECLS duration was 3 days in the last 30 patients. Eleven of patients were newborns. E-CPR was needed in 9 of patients. Non-pulsatile flow and preload control mode (P1 control mode) was used in most patients. P1 (between the patient and the pump head), P2 (pre-oxygenator) and P3 (post-oxygenator) pressures were followed up in all patients.

Results:

In DP2 group, 9 of 25 patients (36%) could be weaned off and 5 patients (20%) were discharged. In DP3 group, 26 of 30 patients (86%) could be weaned off and 15 patients (50%) were discharged. Bleeding and renal failure were the most common complications during ECMO support. Hemodynamic stability, lactate levels and urine output were better in DP3 patients.

Conclusions:

DP3 success is still in progress in comparison with DP2. DP3 provides better hemodynamic stability during support. Also, using proper modes increase efficiency of support.

IL18. An Intravascular Therapeutic Device for Pediatric Patients with Congenital Heart Disease: Mechanical Support of the Fontan Physiology

Amy L. Throckmorton, Ph.D., Associate Professor

School of Biomedical Engineering, Science and Health Systems, Drexel University, Philadelphia, Pennsylvania, USA

Objective: The treatment of single ventricle (**SV**) anomalies is a formidable and costly challenge for clinical teams caring for patients with congenital heart disease (**CHD**). Despite having a low incidence, these patients utilize healthcare resources disproportionate to their numbers. Advances in pharmacologic or novel surgical treatments have reached a plateau, resulting in the need for alternative therapeutic options for SV patients. There is now a growing interest in the use of mechanical assistance as a bridge-to-transplant or treatment strategy. By introducing a pressure boost to the pulmonary circulation analogous to the native right ventricle, the deleterious characteristics of the Fontan may very well be reversed, and the circulation will revert more to normal physiologic levels.

Methods: To address this unmet need, we are developing a mechanical blood pump specifically designed to increase pressure in the great veins would augment flow through the lungs and reverse the Fontan paradox in adolescent and adult patients with ailing single ventricles. We have generated significant preliminary data through numerical modeling, prototype hydraulic evaluation, hemolysis testing, and laser flow measurements to demonstrate the feasibility of our new device.

Results: The pump prototypes were able to generate pressures of 2-40 *mmHg* for flow rates of 0.5-4 *L/min* at rotational speeds of 1000-9000 RPM. Comparisons of the experimental performance data to the numerical predictions demonstrated acceptable agreements within 8-24%. Hemolysis studies revealed average and maximum N.I.H levels were measured to be 0.0056 g/100L and 0.0064 g/100L, respectively, for repeated experiments. Retrograde flow was neither observed, nor measured, from the cavopulmonary junction into the superior vena cava; stereo-laser flow measurements, however, indicated the presence of a threshold where retrograde flow could occur. We measured an enhancement of forward flow into the cavopulmonary junction, reduction in the pressure of the inferior vena cava, and only minimally increased pulmonary arterial pressure under conditions of mechanical pump support.

Conclusions: Considerable progress has been made in the development of a uniquely designed, new therapeutic device for patients with dysfunctional SV physiology. It will serve as a bridge-to-recovery, bridge-to-transplant, or bridge-to-hemodynamic stability for Fontan patients.

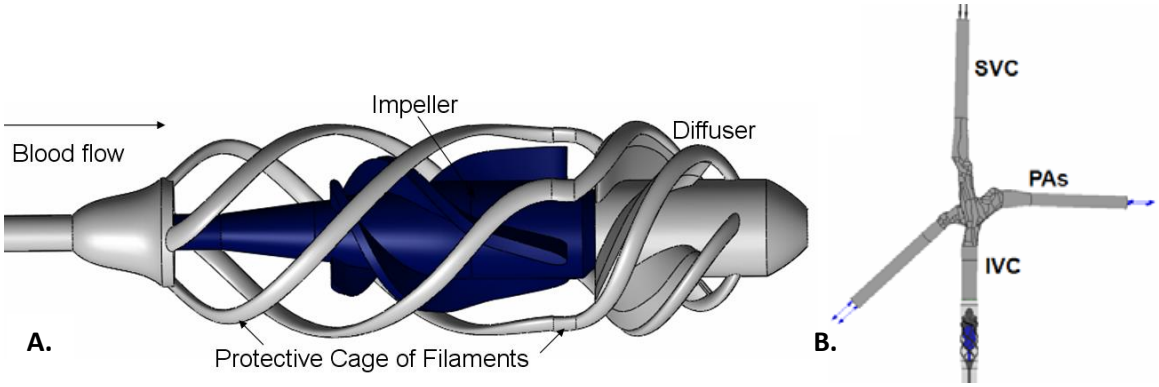

Fig. 1: Intravascular Blood Pump for Single Ventricle Patients. Design consists of a catheter, protective cage of twisted filaments, impeller blade set, and diffuser blade set: A) The device consists of a protective sheath with cage filaments, a rotating shaft and catheter, an impeller blades, diffuser region at the outlet. B) Position of the cavopulmonary assist device in the inferior vena cava (**IVC**). It is designed to augment pressure and thus flow in IVC and subsequently drive blood into the left and right pulmonary arteries while supporting the incoming flow from the superior vena cava (**SVC**).

IL19. Functionalized Tissue Engineered Patches for Pediatric Surgical Reconstructions

***,†Hidetoshi Masumoto, *Fei Ye, *Fangping Yuan, , *§Hiren Trada, *Joseph P. Tinney, and *‡§Bradley B. Keller**

*Kosair Charities Pediatric Heart Research Program, Cardiovascular Innovation Institute, University of Louisville, Louisville, KY; †Department of Cardiothoracic Surgery, Kyoto University, Kyoto, Japan; and ‡Departments of Pediatrics and §Bioengineering, University of Louisville, Louisville, KY

Objective: The generation of tissue engineered patches for congenital cardiac repair requires scalable and implantable 3D biomaterials that include cardiomyocytes (**CM**) and non-CM. Pre-clinical approaches have generated working in vitro engineered cardiac tissues (**ECTs**) from multiple cell sources and a range of 3D formulations. One limitation in generating clinical scale ECTs has been the lack of availability of large numbers of functional CM from somatic cell sources. We are now adapting our ECT approach to incorporate human induced pluripotent stem cells derived CM (**h-iPS-CM**) and non-CM due to the ability to generate large numbers of functioning CM and non-CM. Initial constructs are designed for small preclinical models with the goal of scale-up to large animals.

Methods: h-iPS-CM are stimulated in vitro to generate both CM and non-CM lineages and sorted by CM (VCAM1) and non-CM surface markers. We generate ECTs using h-iPS-CM (CiRA 836B6) embedded into a collagen I and Matrigel construct adapted from our previous methods for chick embryo (Tobita K, et al. 2006) and rat embryo (Fujimoto K., et al. 2011) cells. To facilitate CM maturation, we embed a custom porous electrical sensor and paced constructs at 3Hz. Constructs showed spontaneous contraction by day 5. Constructs are harvested after day 10 for immunohistochemistry to quantify CM and non-CM distribution and maturation, proliferation, and for force-length and force-frequency analysis. Parallel experiments are underway using h-iPS-CM and non-CM in thermal responsive shallow 3D culture plates to generate cell sheets.

Results: ECTs derived from h-iPS-CM and chronically paced at 3Hz display comparable maturation to ECTs derived from embryonic chick and rat CM (**Figure 1**). Despite published evidence that h-iPS-CM display delayed functional maturation, we noted substantial force generation and response to increase pacing rate similar to embryonic chick CM (**Figure 2**).

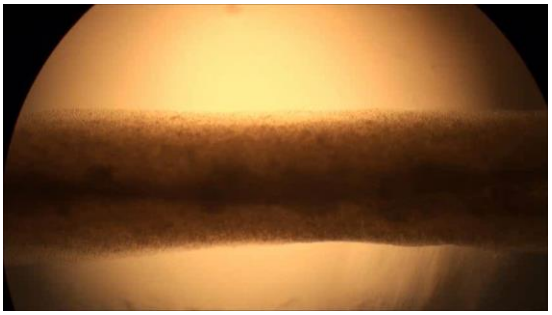

Figure 1. Representative h-iPS-CM derived ECT visualized suspended in a Flexcell Tissue Train plate. This ECT does not contain an embedded PES pacing sensor.

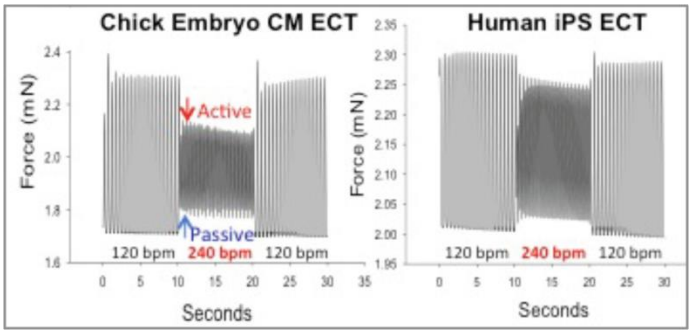

Figure 2. Functional comparison of ECTs generated with chick embryo and h-iPS-CM. Force-frequency relations quantify force generation in response to increased beat rate and reflect maturational ability to release and restore Ca^{2+}. Chick embryo and h-iPS ECT showed increased passive force and reduced active force as beat rate increase from 120 to 240 bpm consistent with immature Ca^{2+} handling.

Conclusions: h-iPS-CM can be incorporated into functional ECTs that generate substantial force and may be scalable to large animal models and then clinical trials.

IL20. Translating Technology into Clinical Practice: a Brazilian Pediatric Ventricular Assist Device Development

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Heart Institute (InCor), University of São Paulo, São Paulo, Brazil

Objective:

Our goal is to create a multidisciplinary team focused on pediatric circulatory assist devices considering the social and economic context of the patient population and medical institutions involved in future device implantation and technology dissemination.

Methods:

Research groups with expertise in cardiovascular bioengineering, material sciences, computational fluid dynamics and pediatric surgery joined to produce and test a pediatric VAD and ECMO system. Polyurethane pulsatile pumps of 15 and 30 mL ejection volumes fitted with biological valves and cannulas were developed. A pneumatic driver unit previously developed for adult patients VAD was adjusted to pediatric assistance. In vitro studies included hemolysis evaluation and flow velocity fields and shear stress determination using particle image velocimetry. Acute studies were performed in piglets (n=14, 10-12 Kg body weight, 2 hours under biventricular assistance). Pre-clinical device performance was assessed in juvenile sheep with an actively contracting ventricle (n=9, 20-30 Kg body weight, 30 days end point) undergoing LV assistance.

Results:

Acute biventricular assistance resulted in stable cardiac index >3 L/min/m2 in all animals. No clinical indicators of embolization or relevant pathology findings were observed in the chronic experiments. Plasma free hemoglobin remained within acceptable levels during assistance. At study termination VAD blood contacting surfaces showed no significant thrombus or fibrin formation except around the annulus of the valves.

Conclusions:

The strategy utilized resulted in an efficient resource utilization and timely development of a pediatric VAD suitable for clinical evaluation. Technology transfer to local industries may lower manufacturing costs contributing to pediatric VAD use with costs in accordance with national healthcare expenditures.

IL21. Advances in Heart Valve Bioengineering with Special Emphasis on Scaling

Rachael Walker-Simon, Pablo Maureira, Melody Dong, and Lakshmi Prasad Dasi

**Department of Mechanical Engineering, Colorado State University, Fort Collins, CO, USA*

Objective:

Are adult diagnostic criteria to characterize severity of valve disease applicable in pediatric patients? The objective of this study is to introduce physical laws that govern the scaling of wasted energy from pediatric valvular conditions and propose a new clinical index to gauge severity.

Methods:

Dimensional analysis of wasted energy reveals a new index, Cardiovascular Efficiency Index (**CEI**), that physically represents the energy ejection fraction of the pumping ventricle (i.e. power generated normalized by power ejected) indexed to patient body surface area. CEI for left-sided disease can be calculated using cuff pressure combined with simultaneous ultrasound measurement of pressure gradient. However, right-sided conditions require catheterization for power calculations. In-vitro studies were conducted using varying degrees of stenotic aortic valves placed in a left-heart simulator subjected to varying hypertension levels (moderate – 140/100 and severe 160/120). This model represents the most complex concomitant pressure loaded condition. Instantaneous pressure and flow measurements yielded CEI for each singular as well as concomitant condition for adult (high cardiac output) as well as pediatric (low cardiac output) conditions.

Results:

Results show that CEI and raw power increased significantly when assessing severity of both singular and concomitant disease cases. CEI reflected a marked decrease in energy efficiency in pediatric cases compared to adult cases (see Figure 1) for the same level of singular as well as combined pathosis. We also demonstrate that CEI captures the total severity in concomitant scenarios better than raw power output.

Conclusions:

The results of this study suggest that standard indices of severity for adult do not translate to pediatric patients due to the nature of energy scaling with respect to cardiac output and patient body surface area. CEI may be the appropriate clinical index to quantify severity of both left and right-sided energy wasting lesions.

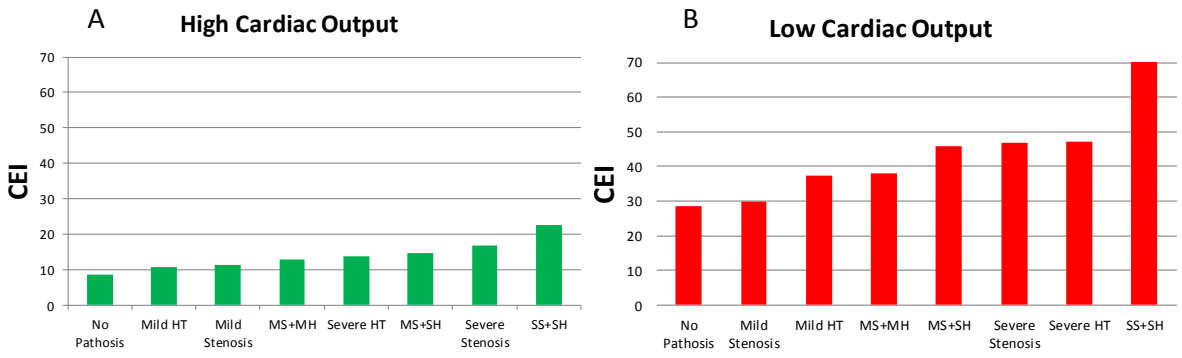

Figure 1. Cardiovascular efficiency index (CEI) for varying levels of pressure overloading for adult conditions (A) and pediatric conditions (B).

IL22. Computational Fluid Dynamics in Congenital Aortic Valve Disease

Giovanni Battista Luciani, MD

Division of Cardiac Surgery, University of Verona, Verona, Italy

Abstract:

Computational fluid dynamics (CFD) using geometric meshes derived from in vivo advanced imaging techniques (MRI, CT) and finite element mathematical analysis has been applied to define pathophysiology of congenital malformations for quite some time. Whereas CFD has been instrumental in selecting the best surgical strategy, from a bioengineering point of view, for staged palliation of single ventricle lesions, more recently it has been employed to investigate the unique interaction between aortic valve structure and aortic pathology in the most common congenital heart defect world-wide, namely bicuspid aortic valve (BAV) disease.

Given the newly recognized prevalence of BAV in healthy Caucasian population ranges between 1-2%, but it is perhaps as high as 5%, interest for clinic-pathological evolution of what is the most common anatomic variant from normal tricuspid aortic valve has dramatically grown. In particular, necessity to distinguish amongst BAV subtypes and to characterize the long-term impact of normally functioning BAV on ascending aortic status has gained possibly greater importance than definition of aortic pathology in BAV patients with dysfunctional valves requiring surgery. In both populations, i.e. healthy subjects with normally functioning BAV and patients with diseased BAV or normal BAV but aneurysmal aorta, late clinical follow-up is impractical and natural history events may require decades to present. Therefore, translational research tools, such as CFD, with the unique ability to simulate the individual anatomy and pathophysiology of BAV may allow patient-specific prediction of very long-term evolution congenital aortic valve and ascending aortic disease.

IL23. Progress in Computational Modeling of Neonatal Cardiopulmonary Bypass Hemodynamics with Detailed Circle of Willis Anatomy

***Senol Piskin, ‡Akif Ündar and *§Kerem Pekkan**

**Department of Mechanical Engineering, Koc University, Sariyer, Istanbul TURKEY, ‡Pediatric Cardiovascular Research Center, Department of Pediatrics Penn State Hershey College of Medicine, Hershey, PA, USA, §Department of Biomedical Engineering, Carnegie Mellon University, Pittsburg, USA*

Objective: This study aims to model and compare the blood flow performance of aortic cannulation configurations during neonatal congenital cardiopulmonary bypass. Cannula configuration is known to influence multi-organ perfusion significantly [1, 2], but this effect was not clear in computational models that focus only the aortic arch region [2]. Therefore we model the main brain arteries including the circle of Willis (CoW) and the Basal Ganglia, which are important due to their role in blood, flow re-distribution, backflow, perfusion and their significance intraoperative monitoring systems (such as NIRS).

Methods: The great arteries of cerebral circulation are reconstructed from patient MRI data. Aortic arch model has been verified in our previous studies. Inlet of cannula is assigned as velocity boundary condition, while all outlets are assigned as resistance boundary conditions. 3D Flow simulations in the aortic arch model are performed at a mean blood flow rate of 500 ml/min (Re 2150). A commercial flow solver Ansys Fluent 15.0 is used.

Results: Flow dynamics of common arch CPB configurations are simulated; hemolysis, blood residence times and wall shear stress distributions are reported. Cerebral perfusion is computed in cases with missing anterior or posterior communicating artery. The cerebral and systemic flow distributions are calculated and compared with previous simulations and found to be different.

Conclusions: Inclusion of 3D CoW is essential to predict the accurate head-neck blood perfusion and therefore detrimental in deciding the neonatal aortic cannulation strategy pre-operatively.

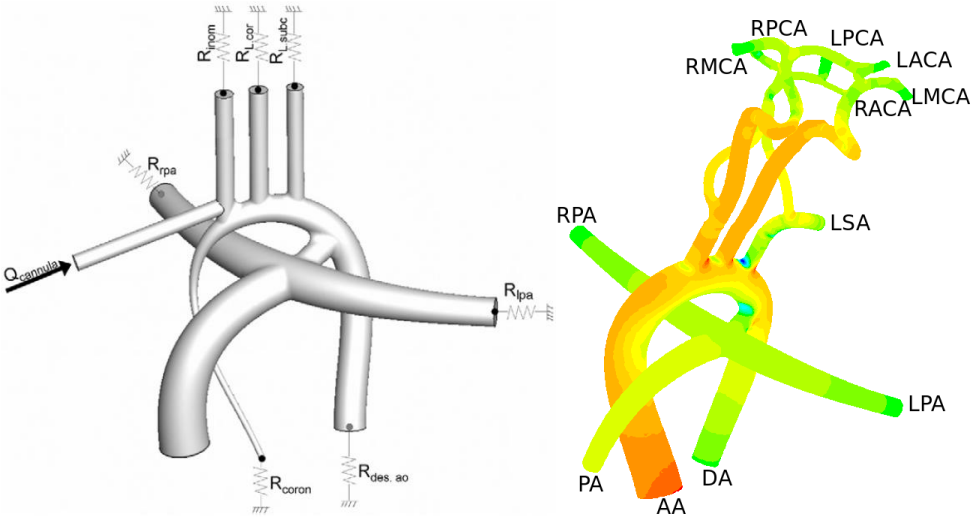

Figure 1: A cannula configuration in neonatal arch reconstruction (left) [2]. Pressure (mmHg) distributions in neonatal aortic arch integrated with with cerebral arteries including CoW region. Flow splits are computed to be (%): 57.3 for DA, 6.7 for RPA, 6.9 for LPA, 12.7 for LSA, 4.4 for RMCA, 4.5 for LMCA, 2.3 for RPCA, 2.5 for LPCA, 0.9 for RACA, 1.8 for LACA (right).

References:

[1] T. A. S. Kaufmann et al, The Impact of Aortic/Subclavian Outflow Cannulation for Cardiopulmonary Bypass and Cardiac Support: A Computational Fluid Dynamics Study, Artificial Organs, 33(9), 2009
[2] D. de Zelicourt et al, Cannulation Strategy for Aortic Arch Reconstruction Using Deep Hypothermic Circulatory Arrest, Ann. Thorac. Surg, 96, 2012

IL24. Is It Time to Go Back to Pulsatile Flow? Consequences of Non-pulsatile and Pulsatile Flow in Cardiopulmonary Bypass and Mechanical Circulatory Support Devices

Jack Copeland, MD

Division of Cardiothoracic Surgery, University of California San Diego, La Jolla, CA, USA

Abstract:

In this talk, I review the question of pulsatile versus continuous flow support in cardiopulmonary bypass and mechanical circulatory support devices. Evolutionary, scientific, and clinical evidence is considered. Continuous flow cardiopulmonary bypass has been perfected and modified and results have been spectacular, but simultaneously, dangers and limitations have been recognized. Hypothermia, limited exposure or no exposure to cardiopulmonary bypass, and improved disposable equipment and methods have helped. Still, cardiopulmonary bypass is associated with complications that limit periods of support, injure organs, and result in post-bypass vasoplegia particularly in sicker patients. Work by some investigators, especially in children, documents superiority of pulsatile flow.

Current clinical results with continuous flow LVADs will be reviewed including some problems that seem to be related to lack of a pulse: gastrointestinal bleeding, aortic insufficiency, and stroke. Some other problems are related to the device itself: acquired Von Willebrand's syndrome and pump hemolysis and thrombosis. GI bleeding with pulsatile VADs is 10 times less. Aortic insufficiency is less common. Von Willebrand's syndrome is not seen and stroke rates with some pulsatile devices have been significantly less.

Modern surgical methods and technology could provide us with the opportunity to use pulsatile flow in cardiopulmonary bypass. Manufacturers of durable support devices may lead the way since they are advertising pulsatility in next generation devices. And evidence suggests that having a pulse is good. My conclusion is that investigation of pulsatile flow in cardiopulmonary bypass and mechanical circulatory support is warranted and may lead to paradigm shifts away from continuous flow.

IL25. Rehabilitation after VAD: Role of Ancillary Staff

Meredith McDonough, MS, CCLS IV , Rebecca F. Hoffritz, PT, DPT, PCS, Meghan Burkhardt, MS, OTR (L)

Cardiac Center Child Life Specialist, Level IV; Cardiac Center Physical Therapist III and Cardiac Center Occupational Therapist, all at The Children's Hospital of Philadelphia.

Background:

As an institution that provides extracorporeal and VAD support, it is important that the interdisciplinary team work together to provide the patients with optimal services, which normalize their experience and maintain or enhance their functional and/or developmental skills. Once on extracorporeal life support, the physical and occupational therapists will work with the patient to maximize strength, joint integrity, development skills, functional mobility, and activities of daily living. Starting with early progressive mobilization, the interdisciplinary team works together to provide optimal care of the patient on extracorporeal support, acknowledging the family also has special needs requiring specific attention. The Child Life Specialist interacts with the patient and the families, to support, educate and normalize the hospital experience during this very stressful process.

Results:

The VAD Program at the Children's Hospital of Philadelphia is made up of an interdisciplinary team that assists patients and their families as they adjust to both the medical and psychological impact of the circulatory support. This team includes the physician and nursing staff in conjunction with physical therapy, occupational therapy, child life, psychology, social work, music and art therapy, speech and nutrition. All services are vital in optimizing the patients' physical, psychological, and spiritual well being so they are able to thrive once transplantation has occurred.

Once the patient has the mechanical device implanted, it is the role of both Physical and Occupational Therapy to provide services, which will maximize the patient's functional mobility and independence. Both Physical and Occupational Therapists identify the need for adaptive equipment, splinting or techniques to promote acquisition of developmental milestones and/or the prevention of decreased range of motion and the incidence of contractures. Physical Therapy and Occupational Therapy often work together, initially, to provide early mobilization and progressive mobility as evidence shows a decrease in muscular atrophy, decrease in days spent in the intensive care unit, and an increase in overall functional gains. Physical Therapists will assist patients in regaining functional mobility, balance, range of motion, strength and endurance to activity. Often after VAD placement, the patient becomes deconditioned, their posture is impacted, and due to how the device is implanted, their balance may be impacted as device weight, drive lines, and cannulas now impact their thoracic cage. Occupational Therapists specialize in fine motor and visual motor function. They will assess the patient's ability to engage in their occupations (accept care, self-calming skills, caregiver bonding, developmental play, self-feeding, ADLs, school, work, and leisure tasks) and address what may hinder their performance.

During mechanical support, the patient and family have special needs requiring specific attention. The goal of the child life specialist is to meet the emotional, social and developmental needs of hospitalized children. Specifically for the patient on circulatory support, the child life specialist provides coping mechanisms and education for the patient and their siblings. The collective goals of the child life specialist for the patient on VAD support are to increase familiarity with the device, encourage mastery and coping skills, facilitate expression of feelings, minimize the impact of living with circulatory support, and to also educate siblings about the device. The child needs to be told why the device is being placed and the importance of the device in their course of treatment. Pictures and age-appropriate materials are used to explain how the device looks and works. Ideally, the optimal timing for preparing the patient is before the implantation of the device if not operatively placed post cardiac arrest. It is critical that the child life specialist is involved in the patients care as they begin to emerge from sedation, so they can partner

with the family and the medical staff to provide developmentally appropriate support and education. All of this is done to attenuate fears and to increase understanding and compliance of the device.

Conclusions:

Evidence demonstrates the importance of early mobilization and progressive mobility to decrease muscle atrophy, length of ICU stay and increase functional gains. Emphasis on treating and supporting the patient and caregivers pre- and post VAD placement in preparation for transplantation or destination therapy is vital. The interdisciplinary staff of The Cardiac Center is part of a highly effective ancillary system that provides excellent support to both the patients and their families during this intense hospitalization.

IL26. Extracorporeal Life Support for Low Flow Applications ECLS Set 2.8 - First Standardized Solution by MAQUET

Thomas Markmann, MBA

MAQUET Cardiopulmonary AG, Rastatt, Germany

Abstract:

The development of ROTASSIST 2.8 – a new generation of centrifugal pump with sophisticated integrated pressure technology – designated for low flow applications, forms the basis for the ECLS Set 2.8. This new standardized circuit for extracorporeal life support is suitable for all indications where cardiac and/or respiratory support with flow rates up to 2.8 l/min is needed.

Another main component of the ECLS Set 2.8 is the advanced version of the QUADROX-iD Pediatric oxygenator which also incorporates integrated and non-invasive pressure measurement at the arterial blood outlet. The complete circuit is CE approved for use up to 30 days.

According to the MAQUET quality policy, a field test has to be performed before the ECLS Set 2.8 can be introduced onto the global market. The aim of the field test is to collect and analyze user opinions concerning handling, design and functionality. It is not meant to prove the effectiveness or the safety of the product as this has already been confirmed in connection with the CE-approval.

The field test took place at 17 pediatric centers in Europe and the Middle East. As of February 2014, 15 pediatric patients have been supported with the ECLS Set 2.8. The clinical indications for the extracorporeal support have been various and both V-A ECMO and V-V ECMO have been performed. The longest support run was 29 days.

IL27. Cost Effective Usage of Terumo Capiox® FX 05 and Baby RX 05 Oxygenators in Extracorporeal Membrane Oxygenation in Infants

Arda Özyüksel, Cihangir Ersoy, Atıf Akçevin, Halil Türkoğlu, Ali Ekber Cicek, Aydin Kahraman, Bekir Kayhan, Emir Canturk

Department of Cardiovascular Surgery, Medipol University, Istanbul, Turkey

Objective: Although the poly-methylpentene (**PMP**) oxygenators have significant advantages in ECMO implementation, their usage may be limited in some situations, which may be related to economic disablements or legal issues regarding to cessation of the unprecedented PMP oxygenators in the market. In this report, we aimed to emphasize our cost effective usage of a membrane oxygenator at the ECMO setup (**Figure 1**).

Methods: We implemented ECMO with eight Capiox® FX05 or Baby RX05 hollow fiber membrane oxygenators in five neonatal patients. The data was evaluated regarding the patient characteristics, indications for ECMO usage, perioperative course and details about the system setup. The average age was 7 months (ranging from 8 days to 12 months), the average weight was 6.240 grams (ranging from 2.400 grams to 10 kg) and the average body surface area was 0.31 m2 (ranging from 0.17 m2 to 0.45 m2). The primary indications for the ECMO implementations were post pericardiotomy low cardiac output status and the associated respiratory complications.

Results: The average ECMO duration was 121 hours (ranging from 41 to 272 hours). The membrane oxygenators were replaced three times for the first and two times for the second patient, respectively. Following the termination of the ECMO, the system was disintegrated into its components for macroscopic analysis. Neither gross blood clots nor plasma leakage were observed in any of the components. Two of the five patients survived with this implementation.

Conclusions: The integration of a centrifugal pump and a separate hollow fiber oxygenator may provide a cost effective ECMO implementation setup with no adverse effects. This system setup may be an encouraging alternative for the low cost usage of ECMO in neonates.

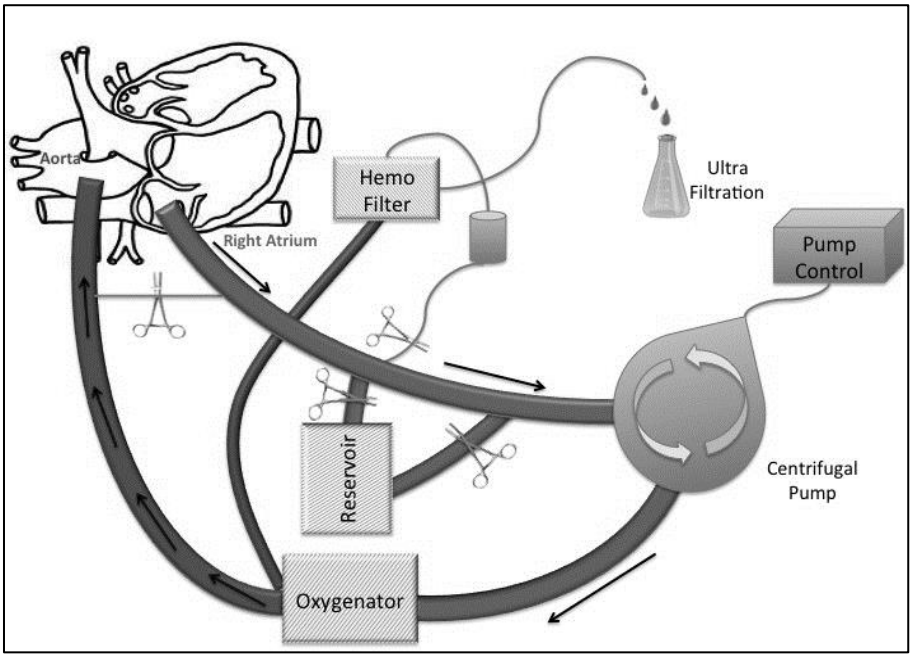

Figure 1: Schematic presentation of the extracorporeal membrane oxygenation system with separate membrane oxygenator.

IL28. Extracorporeal Circulation: Ten-year Practices in China

Wang Wei[1], Hei Fei-long[2], Long Cun[2], Zhu De-ming[1]

[1]Shanghai Children's Medical Center, Shanghai, P.R. China

[2]Fuwai Hospital, National Center for Cardiovascular Diseases, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, P.R. China

Objective:
The first open-heart surgery was undergone in China in 1958 by Hongxi Su. Since that time, more and more doctors engaged in the cardiopulmonary bypass (**CPB**) in China. Remarkable progress has been made over the last 10 years in the extracorporeal circulation (**ECC**). This article is to survey the condition of ECC in China.

Methods:
The number of cardiac surgery, CPB and ECMO, VAD were collected from 2003 to 2012.

Results:
The cases of cardiac surgery increased from 76,319 to 204,988, whereas the cases with CPB from 59,886 to 160,575 in last ten years. In 2003, open-heart surgery was undergone in 467 hospitals whereas in 2013, the number increased to 764. However, the cases in each hospital varied from less than 10 to more than 10,000 cases with near 9,000 CPB cases. The biggest ten center underwent about a quarter of the open-heart surgery. But in about one third hospitals, less than 50 cases per year were treated. It showed the unbalance development among the hospitals.

The rate of open heart surgery and CPB (per ten thousand people) in different province was varied form 0.27, 0.23 in Tibet to 14.04, and 9.21 in Beijing. It suggested the development of different area was varied because most patients prefer to the biggest centers in Beijing and Shanghai. It showed the unbalance among the provinces.

The history of mechanical circulatory support (**MCS**), including ECMO and VAD, was less than two decades, not so long as in developed country. In 2012, 399 patients were supported by ECMO and 738 by VAD. Compared to those of 2004, only 84 cases were treated by ECMO in China. The MCS/CPB rate is only 0.5%, much lower than that in other country. It showed that many severe patients, who need MCS, were not supported by the technique of ECMO and VAD.

Conclusions:
Although the cases number and technology of ECC grew quickly in recent 10 years, it still much room to be improved, including the utility of MCS. In addition, it is necessary to promote of quality control and personal training to balance the differences between regions and hospitals.

IL30. EVLP: How our institution performs

Gregg Roach, CCP, Philadelphia, PA, USA

Abstract:

Presently in organ transplant surgery, the need for transplantable Lungs has greatly increased and with this growing need the availability of viable lungs has remained unchanged. In the past, the problem had been that there are a small number of lungs that are deemed transplantable. Refining the criteria for recipients has helped and sending out for retrieval a consistent procurement team that physically asses the organ has also made the available lungs increase. In addition to these new strategies, another alternative that has surfaced is Ex-Vivo Lung Perfusion (**EVLP**).

At our institution our lung transplant program performs approximately 50 cases per year. Since its inceptions we have done over 800 lung transplants. We now have started investigating the use of EVLP and the long-term benefits of lung reconditioning.

I would like to talk about our experience with this new and evolving technology, how we perform these procedures, and what it's future means to our institution.

IL31. Use of Blood Products in Pediatric Cardiac Surgery

Yves Durandy M.D.

CCML Le Plessis-Robinson France

Abstract:

In pediatric cardiac surgery, there is a big gap between published recommendations or guidelines for blood product use and clinical practice. However, drawbacks of blood transfusion on systemic inflammation and immunity are well acknowledged. The goal of this presentation is to present rationale for packed red blood cells, fresh frozen plasma and platelet use in pediatric patients.

Hemoglobin blood level is the trigger currently use for packed red blood cells transfusion, though it is commonly admitted that this trigger is suboptimal.

An increase in hemoglobin level is likely to be associated with an increase in oxygen blood content and oxygen blood delivery. However above a critical level of hemoglobin normovolemic anemia is well tolerated and an increase in hemoglobin will failed to achieve an increase in oxygen consumption and therefore will not improve end-organ oxygen supply.

Fresh frozen plasma is one way to correct significant coagulation factors deficiency induced by hemodilution, consumption or hepatic insufficiency. The volume of fresh frozen plasma needed to increase these factors is not negligible and whenever possible the use of clotting factor concentrate is recommended. The same remark can be done for treatment of AT III deficiency.

Platelets infusion should be restricted to bleeding patients with thrombopenia and without surgical bleeding. In clinical studies, prevention of bleeding with prophylactic infusion of platelets proved to be useless.

Optimal use of blood products avoiding overuse, underuse and inappropriate use is challenging in pediatric cardiac surgery. No data or guidelines can replace clinical judgment and decision to transfuse is left to individual discretion, but the medical community needs to optimize their transfusion practice, otherwise policy makers without equivalent expertise may regulate blood product use.

IL32. Evaluation of Different Diameter Arterial Tubing and Arterial Cannulae in Simulated Pediatric CPB Circuits

[1]Shigang Wang, [5]Tami Rosenthal, [2]Allen R. Kunselman, and [1,3,4]Akif Ündar

[1]Pediatric Cardiovascular Research Center, Department of Pediatrics, [2]Public Health Sciences, [3]Surgery, Penn State Milton S. Hershey Medical Center, Penn State Hershey College of Medicine, Hershey, PA; and [4]Bioengineering, College of Engineering, Pennsylvania State University, University Park, PA, USA; [5] Cardiovascular Perfusion Department, Children's Hospital of Philadelphia, Philadelphia, PA, USA

Objective:

The objective of this study is to evaluate three different diameters arterial/venous tubing and three diameter arterial cannulae in terms of pressure drop, and hemodynamic energy delivery at in simulated pediatric cardiopulmonary bypass (**CPB**) circuits.

Methods:

The CPB circuit consisted of a Terumo Capiox Baby FX05 oxygenator, arterial tubing (1/4in, 3/16in, or 1/8in x 150cm), and a Medtronic Bio-Medicus arterial cannula (8Fr, 10Fr, or 12Fr). A 300-mL pseudopatient was connected to the circuit. The pseudo patient's pressure was maintained at 50 mmHg by a clamp. The circuit was primed using lactated Ringer's solution and heparinized packed human red blood cells (Hematocrit 30%). Trials were conducted in nonpulsatile mode at different flow rates. Flow and pressure data were collected using a custom-based data acquisition system.

Results:

Using 8Fr arterial cannula at 500ml/min, small diameter arterial tubing generated higher circuit pressure and arterial line pressure drop (**Figure 1**). Table 1 presents pre-oxygenator pressures and arterial tubing pressure drops using 10Fr and 12Fr arterial cannula at different flow rates. High flow rate, hypothermia, small diameter arterial tubing and arterial cannula created more hemodynamic energy at pre-oxygenator site, but energy loss across CPB circuit also increased.

Conclusions:

Although small diameter (<1/4') arterial/venous tubing may decrease total CPB priming volume, it also led to significantly higher circuit pressure, higher pressure drop, and more hemodynamic energy loss across CPB circuit.

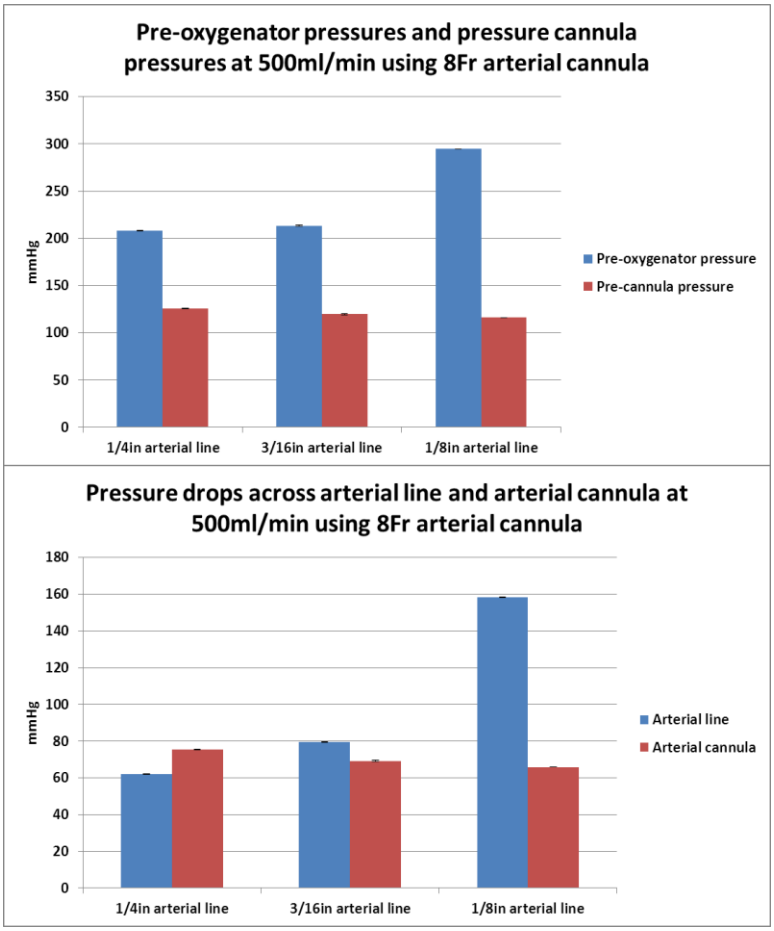

Figure 1. Pre-oxygenator / pre-cannula pressures and pressure drops across the arterial line tubing and arterial cannula.

Table 1. Pre-oxygenator/pre-cannula pressures and pressure drops across arterial line tubing and arterial cannula.

Arterial cannula	Arterial tubing	Flow rate (ml/min)	Pressure (mmHg)		Pressure drop (mmHg)	
			Pre-oxygenator	Pre-cannula	Arterial line	Arterial cannula
10 Fr	1/4 in	1000	248.0±0.3	131.2±0.2	74.0±0.1	80.8±0.1
	3/16 in	1000	266.8±0.2	120.2±0.1	111.6±0.0	69.7±0.0
12 Fr	1/4 in	1500	302.5±0.4	123.8±0.3	92.0±0.2	73.6±0.2
	3/16 in	1500	324.4±0.3	112.2±0.1	154.0±0.1	62.1±0.1

IL33. Developing a Culture of Patient Safety

Talya Frey, BS, CCP, LP, FPP
Staff Perfusionist
The Children's Hospital of Philadelphia, Philadelphia, PA, USA

Abstract:

The Joint Commission on Accreditation of Healthcare Organizations (**JCAHO**) defines a sentinel event as "…An unexpected occurrence involving death or serious physical or psychological injury, or the risk thereof. Serious injury specifically includes loss of limb or function. Such events are called "sentinel" because they signal the need for immediate investigation and response." Global changes are often times difficult to implement, and even harder to quantify the result for effectiveness.

At The Children's Hospital of Philadelphia (**CHOP**), there has been a major focus in improving patient outcomes through launching numerous institutional initiatives. This Journey of Safe Keeping began a little over 5 years ago with educating staff to "Practicing with a Questioning Attitude". Later, new goals such as monitoring the percentage of time staff performed Hand Hygiene, and monitoring the incidence of Central Line Associated-Blood Stream Infections were added. This year, we continue to educate ALL CHOP staff with a 3 hour course that not only challenges players to practice and apply knowledge of our existing safety behaviors, but also introduce two new safety behaviors: recognizing and preventing cognitive bias, and improving communication.

This presentation explores our journey to become the safest pediatric hospital in the country by 2015.

S1. Simultaneously Monitoring of Cerebral and Somatic NIRS Values (Renal and Hepatic) in Children Who Were in First 2 Age Undergone Cardiac Surgery: Results and Correlations

Tijen Alkan-Bozkaya[1], Tuğrul Örmeci[2], Cihangir Ersoy[1], Arda Özyüksel[1], Burak Arkan[1], Atıf Akçevin[1], Halil Türkoğlu[1], Akif Ündar[3]

Istanbul Medipol University, Dept. of Cardiovascular Surgery[1] and Radiology[2], Istanbul, TURKEY, Penn State University, Children's Hospital, Hershey[3], PA, USA

Objective: The cerebral, somatic NIRS values and perfusion markers for the assessment of splanchnic tissue perfusion after open heart surgery in pediatric patients were correlated with the postoperative clinical outcome.

Methods: There are total 39 pediatric patients (0-2yrs old) which they undergone cardiac surgery in our pilot study. 24 of them were in early infantile age (0-3mos) group. We divided in this group 2 categories according to cyanosis: Group I: Cyanotic group (n = 29) and Group II: Acyanotic (n =10). All of patients were categorized according to Aristotle Complexity Score and Jenkins risk stratification. In Cyanotic group including 11 Single Ventricle (1V) patients and 18 biventricular repair (2V) patients (14 with d-transposition of the great arteries who underwent arterial switch operation).

The cerebral and somatic (renal and hepatic) NIRS values with renal and hepatic Doppler values (RI and peak systolic) were recorded at the same time for each patient (postoperative 1st 4 hour). Descending aorta Doppler measurements and NIRS values were also recorded. All of somatic NIRS measurements were taken directly under ultrasound. Results were assessed by statistical analysis.

Results: NIRS database was shown that the mean postoperative rSO2i was higher in the two ventricle (2V) group (71%±7 vs. 45%±5, $p<0.001$). 72% of the single ventricle rSO2i values were 50% or below, and 25% of values 40% or below; versus only 12% of values 50% or less, and only 0.1% below 40% in the two ventricle patients ($p<0.001$) rSO2i exhibited a positive correlation with SpO2 in the SV group (Pearson correlation 0.25, $p<0.001$), and a negative correlation with the 2V group (Pearson –0.20, $p<0.001$).

We found also the cerebral and somatic NIRS (renal, hepatic and descending aorta) values were higher significantly at the acyanotic group. (Cerebral p= 0.28; renal p= 0.23; hepatic p= 0.01 and desc.aorta p=0.14) and lactate levels were higher significantly at the cyanotic group and these values were correlated with NIRS values (p= 0.034).

All patients survived to hospital discharge except 3 with HLHS who undergone the Norwood procedure, those 3 patients and 2 of 2V patients had depressed level of consciousness and seizures. There were ischemic changes in basal ganglia and cortex on MRI; all of these patients had low NIRS values (rSO2i <50%) in the 48 hours perioperatively. There was no neurologic deficit was seen clinically at the alive patients but they follow up by the Pediatric Neurology. Results were confirmed by the EEG screening peroperatively in all patients who were undergone CPB or arch repair operation. Pulsatile perfusion mode was used to all patients who had undergone CPB.

Conclusions: The threshold for low rSO2i values associated with neurological dysfunction is estimated to be 40%. In cyanotic group with single ventricle pathology, the majority of postoperative rSO2i values was below 50%. Very low rSO2i may be associated with the frequent appearance of new hypoxic-ischemic brain lesions seen on postoperative MRI.

We thought that cerebral and somatic NIRS monitoring is clinically useful tool for pediatric open-heart surgery, especially early postoperative period.

S2. Total Artificial Heart Bridge to Transplantation in Pediatric Patients, a 10 Year Follow-up in 3 Patients

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Objective: Over 1260 orthotropic pneumatic pulsatile total artificial hearts for bridge to transplantation have been implanted including over 160 during the past year. Among these have been an increasing number of implants in adolescents. We report here experience with 3 patients under the age of 18 years.

Methods: We have reviewed our experience with 3 pediatric bridge to transplant patients beginning in October 2003 with 10 year follow-up.

Results: Age, gender, body size, etiology of cardiac disease, support pre-implant, and reason for use of TAH are shown in the table.

Patient	Age (yrs)	Gender	Ht(cm)/wt(kg) /BSA(sqm)	Etiology	Support pre-implant	Reason for implant
1	17	M	176/88/2.11	Methamphetamine cardiomyopathy	IABP, dob, mil, epi	Shock
2	14	F	155/57/1.55	D-transposition post-MVR	Vent, ECMO, Dob, mil, epi	Cardiac arrest
3	15	M	182/80/2.01	Becker's muscular dystrophy	ECMO	Cardiac arrest

Patient 1 was the size of a large adult at presentation, had massive cardiomegaly, and was transferred to us in cardiogenic shock on IABP and multiple inotropes. He was transplanted after 56 d of TAH support. He is currently alive and working as a skilled laborer 7 years post-transplantation.

Patient 2 was transferred to us after hemodynamic collapse and cardiac arrest following a mitral valve replacement for mitral regurgitation complicating D-transposition of the great vessels. She had an atrial septostomy and BT shunt followed by a Mustard repair as a baby. She presented on ECMO and multiple inotropes with a blood pressure of 73/53 and had a dilated systemic ventricle. She was 155 cm tall and weighed 57 kg with a BSA of 1.55 m2, a body size that, were it not for her huge heart, would have been a contraindication to TAH implantation. However, the TAH fit nicely and she made a rapid recovery of all organs with no adverse events and was walking > 600 feet daily at the time of her transplant after 30 days of support. She died of primary graft failure that was felt to be due to preservation injury by clinical and histologic criteria.

Patient 3 had massive 4 chamber cardiac dilatation secondary to Becker's muscular dystrophy. He had a cardiac arrest during his pre-transplant right heart catheterization and could not be resuscitated. He was placed on ECMO in the catheterization laboratory and taken for emergent TAH implantation. The right and left ventricular walls were < 5mm in thickness and we found scattered and previously undetected mural thrombi of the left ventricle. He was transplanted after 63 days of support. After discharge, he completed high school. He is alive and functional 10 years post-transplantation.

Conclusions: All 3 of these patients survived bridge to transplant periods of support ranging from 30 to 63 days on a TAH without any major adverse event. All were transplanted. Two of the 3 have had long term survival. The 14 year old female was supported successfully, but died after transplantation of primary graft failure. Although she was small in stature, there was adequate pericardial space for TAH implantation because of her enlarged heart. These 3 cases are examples of some risks and benefits that arise in pediatric bridge to transplantation with a TAH.

S3. Pediatric Centrifugal Assist Devices in a Developing Country: An Efficient and Economical Option to Treatment the Postcardiotomy Heart Failure - Institutional Experience

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Abstract:

Despite many improvements in the treatment of children with postcardiotomy heart failure resistant to conventional medical therapy, this remains a significant problem in the pediatric population. To keep children alive until restore cardiac function, mechanical circulatory assistance is sometimes needed. Historically, there have been used non-pulsatile devices such as extracorporeal membrane oxygenation (**ECMO**) and centrifugal pumps.

We present institutional results with a series of 5 pediatric patients by applying the centrifugal pump as a rescue therapy in postcardiotomy syndrome

At the National Institute of Cardiology Ignacio Chavez of Mexico City in the last 3 years (2012-2014), five cases operated for congenital heart disease have required the use of a centrifugal pump to restore cardiac function. Cases: Transposition of the great arteries (2), Atrioventricular canal type A Rastelli (1) , Ischemic heart disease secondary to Kawasaki disease(1) and Double Outlet Right Ventricle type Taussig Bing (1). Three of them were females. The mean age was 5.4 years (1-15 years old). And the average time required for the implementation of the centrifugal pump was 622 min with 60% survival.

More appropriate circulatory support can be provided by a mechanical ventricular assist device (**VAD**), which acts as a bridge to recovery, allowing for short-term support. These improve patients' circulation and reverse end-organ dysfunction while permitting physical rehabilitation to improve the patient's overall condition and likelihood for successful surgical results. Therefore, for Institutions like ours, centrifugal pump is an efficient and economical option to treatment the postcardiotomy heart failure.

S4. Interhospital Transport with Extracorporeal Life Support in Pediatric Patients

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Objective:

Pediatric patients (<18-year-old) with severe cardiac or pulmonary failure who require transport to a medical center are challenge. Mechanical support in the form of extracorporeal membrane oxygenation (**ECMO**) may increase the safety of transporting such patients to an institution where they will have access to advanced medical therapy. We reported the experience and result of pediatric ECMO transportation in our hospital.

Methods:

From January 2000 to January 2013, 36 pediatric patients were successfully cannulated and placed on a simplified ECMO circuit at other institutions and transported to National Taiwan University Hospital. The mean age was 8.3 years old (ranged from 2 days to 17 years). There were 15 boys and 21 girls. 14 patients were diagnosed as acute respiratory distress syndrome (**ARDS**). 4 of them were supported with veno-venous (**VV**) ECMO and 10 of them with systemic shock were supported with veno-arterial (**VA**) ECMO. 7 newborns with persistent pulmonary hypertension were supported with VA ECMO. Other patients included 12 acute myocarditis, 2 hypertrophic cardiomyopathy (**HOCM**) and 1 dilated cardiomyopathy (Interhospital Transport) were placed on VA ECMO for isolated cardiogenic shock.

Results:

The median distance from unit to unit was 9.6 miles (interquartile range 4-45 miles). There was no transport-related morbidity or mortality. The median duration of ECMO support was 13 days (interquartile range 3-36 days). 22 patients (61%) were successfully weaning from ECMO and 21 patients (58%) were survived up to 3 months and were discharged from the hospital. The survival rate was 50% in ARDS group and the survival rate was 42% in acute myocarditis group.

Conclusions:

Critically ill pediatric patients with severe respiratory failure or cardiogenic shock can be safely transported on VV or VA ECMO support to regional ECMO centers.

S5. Determination of a New Mutation in MT-ND1 gene of a Patient with Dextrocardia, Ventriculoarterial Discordance and Tricuspid Atresia

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Objective: We sequenced the entire mtDNA genome from the cardiac atrium tissue sample of a 5 year old girl with dextrocardia, ventriculoarterial discordance and tricuspid atresia in order to determine the potential risk factors of mtDNA mutation.

Methods: Genomic DNA was extracted from the atrial cardiac tissue samples. mtDNA was amplified in two overlapping PCR fragments (9731bp and 12083bp) using Roche Expand Long Range PCR dNTPack (Roche Applied Science Indianapolis, IN). Next generation sequencing was performed using GS FLX 454 Life Sciences (Roche) platform. The sequence reads (average length 237 bp) were aligned according to the revised Cambridge Reference Sequence (**rCRS**) (NC_012920) using CLCBIO Genomic Workbench v6.5.1 (CLCBIO, Denmark). Each mtDNA sample was sequenced with average ~84,30X coverage. Then, single nucleotide polymorphisms (**SNPs**) and deletion-insertion polymorphisms (**DIPs**) of the patient were determined according to the following criteria: variants i) at least in three unique (non-duplicate) sequencing reads with both forward and reverse reads, ii) at least 10% frequency among total unique sequencing reads at that location, iii) at high quality scores (>Q20 for variants and >Q15 for 3 nucleotides at each side of variant). The variations at homopolymeric (>4bp) regions were filtered following a probabilistic variant detection approach.

Results: In total, 1.732.120 bases were sequenced. 1.396 979 bases were mapped to rCRS with 237 bp average fragment length, and average depth was ~84,30X. 26 homoplasmic and 46 heteroplasmic variations were detected according to the criteria mentioned above. The distribution of variations was shown in Table 1. All homoplasmic and heteroplasmic variations (with the 10% cut-off) have been determined and evaluated.

Conclusions: A nonsynonymous new mutation was detected at the MT-ND1 gene position 3839 C>T Ser178Leu. The patient was clearly in haplogroup M7d.

Table 1: Distribution of mtDNA homoplasmy and heteroplasmy frequency in atrium sample.

Reference Position	Reference	Allele	Zygosity	Coverage	Frequency	Overlapping annotations	Amino acid change
2706	A	G	Homozygous	26	100	16S rRNA, Gene: RNR2	
3839	C	T	Heterozygous	583	37	Gene: ND1, CDS: ND1	YP_003024026.1:p.Ser178Leu
4071	C	T	Homozygous	95	99	Gene: ND1, CDS: ND1	
4820	G	A	Heterozygous	70	49	Gene: ND2, CDS: ND2	
5351	A	G	Homozygous	82	100	Gene: ND2, CDS: ND2	
5460	G	A	Homozygous	84	90	Gene: ND2, CDS: ND2	YP_003024027.1:p.Ala331Thr
6455	C	T	Homozygous	58	91	Gene: COX1, CDS: COX1	
7028	C	T	Homozygous	56	98	Gene: COX1, CDS: COX1	
7684	T	C	Homozygous	53	100	Gene: COX2, CDS: COX2	
7853	G	A	Homozygous	70	100	Gene: COX2, CDS: COX2	YP_003024029.1:p.Val90Ile
8701	A	G	Homozygous	690	99	Gene: ATP6, CDS: ATP6	YP_003024031.1:p.Thr59Ala
8860	A	G	Homozygous	856	100	Gene: ATP6, CDS: ATP6	YP_003024031.1:p.Thr112Ala
10398	A	G	Homozygous	58	100	Gene: ND3, CDS: ND3	YP_003024033.1:p.Thr114Ala
10400	C	T	Homozygous	55	98	Gene: ND3, CDS: ND3	
10873	T	C	Heterozygous	67	54	Gene: ND4, CDS: ND4	
11719	G	A	Homozygous	104	100	Gene: ND4, CDS: ND4	
12358	A	G	Homozygous	118	99	Gene: ND5, CDS: ND5	YP_003024036.1:p.Thr8Ala
12405	C	T	Homozygous	88	99	Gene: ND5, CDS: ND5	
12705	C	T	Homozygous	70	96	Gene: ND5, CDS: ND5	
14053	A	G	Homozygous	27	96	Gene: ND5, CDS: ND5	YP_003024036.1:p.Thr573Ala
14314	A	G	Homozygous	34	97	Gene: ND6, CDS: ND6	
15301	G	A	Homozygous	23	87	Gene: CYTB, CDS: CYTB	
15326	A	G	Homozygous	27	100	Gene: CYTB, CDS: CYTB	YP_003024038.1:p.Thr194Ala
16129	G	A	Homozygous	25	96	D-Loop	
16239	C	T	Homozygous	20	95	D-Loop	

S6. Cardiopulmonary Bypass Priming Using Autologous Cord Blood in Neonates with Congenital Heart Disease

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Objective:

This study aimed to assess the feasibility of cardiopulmonary bypass (**CPB**) priming using autologous cord blood in neonatal congenital cardiac surgery.

Methods:

From January 2012 to February 2014, four neonatal patients used their own cord blood for CPB priming in congenital cardiac surgery. The cord blood had been collected during delivery and stored immediately in blood bank after informed consent.

Results:

All neonates underwent corrective surgery. The congenital heart disease of them included total anomalous pulmonary venous return (**TAPVR**), transposition of great arteries (**TGA**) with intact ventricular septum and coarctation of aorta (**COA**) with ventricular septal defect. The median age and body weight at total corrective surgery was 8 days (from 1 to 15 days) and 2.98 kg (from 2.18 to 3.65 kg). The median amount and hematocrit of collected cord blood during delivery was 62.5 mL (from 43 to 100 mL) and 49.7 % (from 32.0 to 51.2 %). The median preoperative hematocrit of neonates was 37.5 % (from 31.0 to 45.0 %). And the median amount of CPB priming was 127.5 mL (From 120 to 130 mL). The three out of four neonates did not need allo-transfusion in CPB priming and only one neonate used 20 mL of packed RBC in CPB priming to obtain target hematocrit.

Conclusions:

The autologous cord blood can be used for CPB priming in neonatal congenital cardiac surgery. The auto-transfusion of cord blood can replace transfusion of packed RBC in CPB priming partially or totally.

S7. A CPB Circuit and Protocol for Comparing Continuous and Pulsatile CPB in a Single Animal

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Objective: The need for pulsatile flow (**PF**) as compared to continuous flow (**CF**) during cardiopulmonary bypass (**CPB**) is still being debated. A challenge when using animal models to compare different pumping mechanisms is animal-to-animal variations. We are interested in developing an approach to evaluate CF and PF in a single animal to minimize these variations.

Methods: We developed a protocol in which 30-40 kg pigs are surgically prepared for CPB. A CF pump (COBE Cardiovascular, Inc., Arvada, CO) is placed in series with a PF pump (VentriFlo, Design Mentor, Inc., Pelham, NH) such that either pump can be used to drive blood through a standard CPB circuit. After cannulation, pigs are placed on a single pump for 30 minutes before being switched to the other pump. The pumps were switched a total of 6 times over the course of a 3-hour CPB run. Venous and arterial blood are drawn throughout the experiment and blood gasses are assayed and used to compare the different pumping mechanisms.

Results: Two pigs were successfully placed on CPB using the developed protocol (**Figure 1**). Both animals were kept on CPB for over 3 hours using the switched pumping scheme with an average flow rate of ~2.4 L/min. PF was observed to generate more physiologically equivalent flow and pressure waveforms as compared to CF (**Figure 2**). Because of the small number of animals, no significant differences were noted in blood gasses between the different pumping mechanisms.

Conclusions: It is possible to include two different pumps within a single CPB circuit and to switch between these during a CPB run. This approach enables one to compare pumping mechanisms within a single animal, which will help to reduce variations present when comparing different flow and pressure profiles.

Funding: Granite State Technology Innovation Grant - NH Innovation Research Council

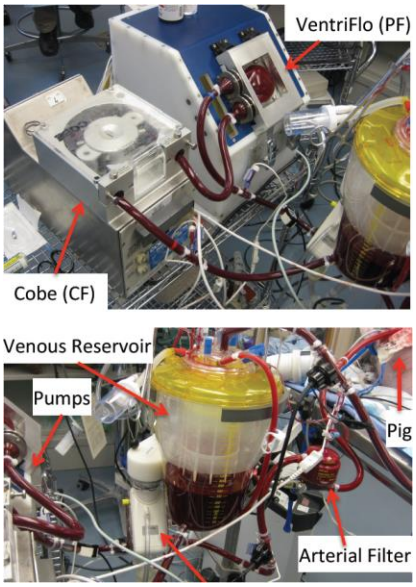

Figure 1. Circuit implementation. Top: Side-by-side CF and PF pumps with short tubing segments connecting the two to minimize prime volumes. Bottom: Complete circuit using clinically standard components; animal and cannulation site in the top right corner.

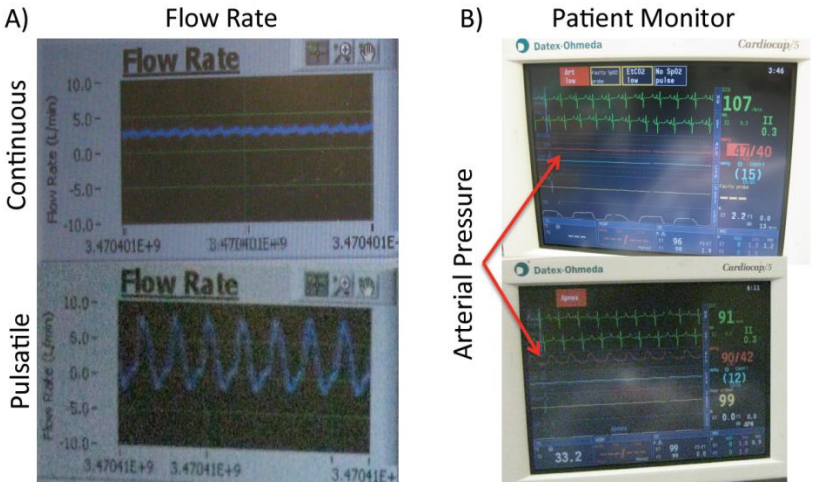

Figure 2. A) Flow profiles for the CF and PF pumping periods measured at the input to the arterial cannula (output of arterial filter) with a Transonic HQT100 flow meter interfaced through a NI DAQ 6212 data acquisition unit and controlled through LabView 2010 software. B) Patient monitor. The arterial pressure waveforms, obtained through a femoral line, for both PF and CF pumping mechanisms are noted. CF had a systolic/diastolic pressure differential of 47/40 while PF had a differential of 90/42. Also note that PF had a pulse-ox reading of 99% (yellow number on bottom right of monitor), whereas with CF no reading was possible.

S8. Myocardial Histology of Neonatal Piglets after Cardioplegic Protected Cardiac Arrest on Cardiopulmonary Bypass

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Objective:
In a previous study we found that death of neonatal piglets early after cardiopulmonary bypass (CPB) was not determined by low cardiac output. In a next step, the explanted hearts of the piglets underwent histological examination regarding myocardial tissue alterations. Finally, these changes were compared to the histological findings of control piglets.

Methods:
Initially, 10 neonatal piglets (younger than 7 days) were connected to CPB for 180 minutes, including 90 minutes of cardioplegic heart arrest at 32°C. In the first hours after CPB (median 3.3 hours), six piglets died and these piglets formed the non-survivors group (CPB-NS group). The remaining animals were sacrificed 6 hours after CPB (CPB-6 group; n=4). The hearts were explanted and myocardial biopsies were taken, fixed, and stained with H&E using standard histological techniques. The specimens were scored from 0 to 3 regarding histological alterations. The data of tissue probes were evaluated and compared to the probes of animals handled comparable to previous piglets but without CPB (non-CPB group; n=3) and to sibling piglets without specific treatment (control; n=5).

Results:
Although the myocardial histological score of CPB-6 group and CPB-NS group were higher than non-CPB group (2.0±0.8, 1.5±0.9, and 0.8±0.3 respectively), these differences were not statistically significant. But compared to control animals (score 0.3±0.5) the scores of CPB-6 and CPB-NS groups were significantly higher ($p<0.05$). Between the left and the right ventricular tissue there were no significant differences.

Conclusions:
The present study revealed significant myocardial tissue alterations after cardiac arrest on cardiopulmonary bypass in newborn piglets. These alterations are primarily related to surgical trauma and then potentiated by the myocardial ischemia. Additionally, the data show that outcome is not related to degree of tissue alteration.

S9. Blood-Surface Interaction and Aggregation of Serum Proteins during Extracorporeal Circulation with Phosphorylcholine-Coated Tubing Lines: S100A8/A9 is it the Trigger for Inflammation?

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Objective:

Extracorporeal circulation procedures have been shown to induce complement and leukocyte activation, release of endotoxin, inflammatory mediators and also protein expression. The aim of the study was to evaluate the affinity of these proteins to the phosphorylcholine coated (PCC) and conventional (Non-Coated) extracorporeal circulation (ECC) tubing.

Methods:

Thirty-three consecutive elective coronary bypass grafting cases were included in the study. Patients were randomly assigned to PCC (18 patients) and non-coated (15 patients) ECC circuits. Serial blood samples were taken before, during and after ECC, and all the tubing lines were cleaned following perfusion for protein analysis. All tubes were treated with reducing buffer and samples and negative controls were run on a gradient SDS-PAGE gel electrophoresis stained with Coommassie staining. Marked protein bands were excised from the gel and digested with trypsin. Protein fractions were determined using Matrix Assisted Laser Desorption Ionization-Time of Flight (MALDI-TOF). Analysis of mass data was done using the Mascot software blasted against swissport database. S100A8 and S100A9 specific antibodies were used for immunoblotting experiments.

Results:

Analysis of the tubing systems for protein aggregations revealed a prominent band on the SDS-PAGE gel. MALDI-TOF test results pointed out the S100A8 and S100A9 proteins. Immunoblotting showed a clear demonstration of S100A8-S100A9 heterodimer aggregation on the tubing samples but none was observed in the serum samples.

Conclusions:

S100 proteins are known to be important for cardiac function. The S100A8 and S100A9 are members of the EF-hand family of proteins in which the S100 proteins constitute the largest subfamily. S100A8 and S100A9 are small calcium-binding proteins that are highly expressed in neutrophil and monocyte cytosols. Recent studies showed that S100A8, S100A9, and S100A8/A9 heterodimer are potent stimulators of neutrophils and that they are found at high levels in the extracellular milieu during inflammatory conditions or sepsis. Although phosphorylcholine coated ECC systems are designed to improve hemocompatibility, our study showed that even coated systems are still open targets for the neutrophils willing to trigger an inflammatory status during cardiopulmonary bypass.

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P1. Use of a Novel Diagonal Pump in an In Vitro Neonatal Pulsatile Extracorporeal Life Support Circuit

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Objective: One approach with the potential to improve morbidity and mortality rates following extracorporeal life support (**ECLS**) is the use of pulsatile perfusion. Currently, no ECLS pumps used in the United States can produce pulsatile flow. The objective of this experiment is to evaluate a novel diagonal pump used in Europe to determine whether it provides physiological pulsatility in a neonatal model.

Methods: The ECLS circuit consisted of a Medos Deltastream DP3 diagonal pump, a Hilite 800LT polymethylpentene diffusion membrane oxygenator, and arterial/venous tubing. A 300-mL pseudopatient was connected to the circuit using an 8Fr arterial cannula and a 10Fr venous cannula. A clamp maintained constant pressure entering the pseudopatient. The circuit was primed using lactated Ringer's solution and packed human red blood cells (HCT 35%). Trials (64 totals) were conducted in nonpulsatile and pulsatile modes at flow rates of 200 mL/ min to 800 mL/min. Flow and pressure data were collected using a custom-based data acquisition system.

Results: The Deltastream DP3 pump was capable of producing adequate quality of pulsatility (**Figure 1**). Pulsatile flow produced increased mean arterial pressure, energy equivalent pressure (EEP), and surplus hemodynamic energy (SHE) at all flow rates compared to nonpulsatile flow (**Figure 2**). Pressure drop across the cannula accounted for the majority of pressure loss in the circuit. The greatest loss of SHE and total hemodynamic energy occurred across the arterial cannula due to its small diameter.

Conclusions: The Deltastream DP3 pump produced physiological pulsatile flow without backflow while providing EEP and SHE to our neonatal pseudopatient. Further experiments are necessary to determine the impact of this pulsatile pump in an in vivo model prior to clinical use.

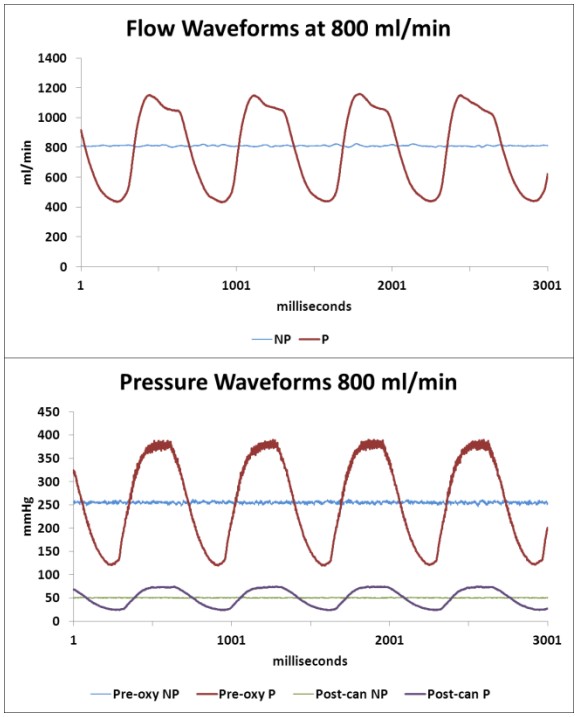

Figure 1. Flow and pressure waveforms at 800 ml/min in non-pulsatile (NP) and pulsatile (P) mode.

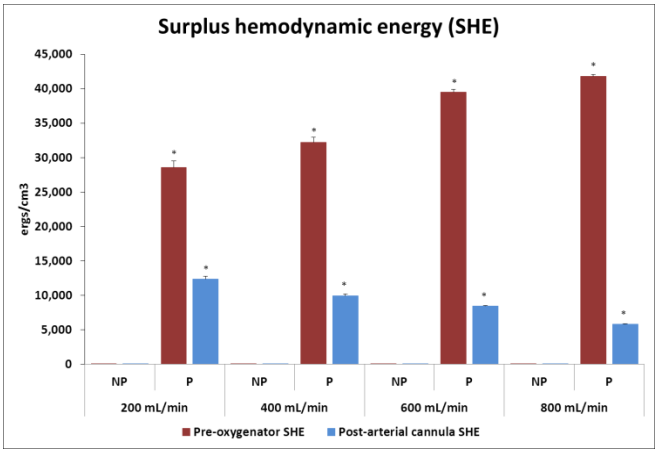

Figure 2. Surplus hemodynamic energy (SHE) at the preoxygenator and post-arterial cannula sites in nonpulsatile (NP) and pulsatile (P) mode at varying flow rates. *P < 0.001, NP vs. P.

P2. Weaning Strategy in Pediatric Extracorporeal Support for Lung Disease

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Objective:

In patients with severe respiratory failure due to lung diseases, extracorporeal membrane oxygenation (**ECMO**) is useful to support the patient until the lung recovery. Veno-venous (**VV**) ECMO can provide adequate oxygenation and is the standard choice for pure respiratory failure. However, if the patients combined shock is refractory to inotropic agents or fluid challenge, veno-arterial (**VA**) ECMO can provide oxygenation and maintain organ perfusion. The VA mode has more complication than VV mode. It included bleeding and arterial embolic events. The longer duration of ECM support, the more complication could happen. In order to minimize the complication and increase the survival rate, we chose VA mode as initial support for respiratory failure with shock and shift to VV mode as soon as possible when the hemodynamic status was stabilized. We reported our experience and compared to previous reports.

Methods:

From January 2007 to January 2014, 12 pediatric patients (<18 years old) in our hospital were supported with VA ECMO initially due to shock status and we shifted to VV ECMO when the hemodynamic status was stabilized after treatment. The mean age was 5.6 years old (ranged from 0 days to 17 years). There were 7 boys and 5 girls. 8 patients were diagnosed as acute respiratory distress syndrome (**ARDS**) due to pneumonia. 3 neonatal patients were diagnosed as primary pulmonary hypertension (**PPHN**), included two congenital diaphragm hernia and one meconium aspiration syndrome. 1 of them had CPR history due to desaturation.

Results:

The median of total ECMO support duration was 24 days (interquartile range 9-30 days). The VA ECMO support duration was 12.75 days (interquartile range 6 to 19 days). 11 (91.6%) of them were successful weaning from ECMO and discharge. 3 patients had neurological sequel related to hypoxia encephalopathy. None of them have complication about limbs ischemia or embolic problem.

Conclusions:

The strategy of VA ECMO for initial unstable hemodynamic status and shifting to VV ECMO after stabilization reduced complications of prolonged ECMO use.

P3. Surgical Approach to Aorticopulmonary Window Accompanied by Interrupted Aortic Arch in Newborn and Results

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Objective:

Aortic coarctation (**AoCoA**) the timing of surgical intervention in the neonatal and infant groups still have a high risk of this group vary from center to center due. Our study in a single center with neonatal and infant aortic coarctation patients were operated in the group and their pre and postoperative surgical approach and our results we aim to provide.

Methods:

Between 2002 to 2014, 24 patients which had APW pathology with the signs of cardiac failure mainly were operated in our clinic. 14 of them had associated with APW and ınterrupted aortic arch. All of them were low birth weight (under 1500 grams) and mean weight was 1.4 kg. They were taken to the surgery emergently by echocardiographic diagnosis. In all of the cases, complete correction was successfully achieved in a single session via median sternotomy and with cardiopulmonary bypass (**CPB**) and total circulatory arrest (TCA, 18℃). Pulsatile perfusion mode was used in all cases during CPB.

Results:

Three patients were died at early postoperative period because of pulmonary hypertensive crises. Early and late postoperative periods of our 21 cases in the 6-48 monthly follow-up have no problem. Short intubation period (8±2.32 hours) and short ICU (2.21±0.03 days) and hospital stay (7.4±0.42 days) were observed in all lived patients.

Conclusions:

According to our clinical experience, early surgical intervention to aortic arch obstructions by median sternotomy can be performed with an acceptable risk potential. We thought that early intervention and especially pulsatile perfusion mode is more suitable choice in this high risk group (according to improved patient outcome in maintaining better cardiac, renal and pulmonic function) in the early postoperative period.

P4. Evaluation of Four Pediatric Cardiopulmonary Bypass Circuits in Terms of Perfusion Quality and Capturing Gaseous Microemboli

Ryan K. Mathis[1], Judith Lin[1], Natalie M. Dogal[1], Feng Qiu[1], Allen R. Kunselman[2], Shigang Wang[1] and Akif Ündar[1,3]

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Objective:

This study compared four pediatric cardiopulmonary bypass (CPB) circuits with four different hollow-fiber membrane oxygenators and their specific reservoirs, Capiox RX15, Quadrox-i pediatric, Quadrox-i pediatric with integrated arterial filter (IAF) and KIDS D101, in a simulated CPB circuit to test their ability to maintain hemodynamic properties, remove gaseous microemboli (GME), and to test the amount of blood "stolen" by the arterial filter purge line.

Methods:

The circuit was first primed with Ringer's Lactate solution, then red blood cells were added and the hematocrit was maintained at 30%. A 5-cc bolus of air was injected just proximal to the venous reservoir over a thirty-second interval and GME were monitored using an Emboli Detection and Classification quantifier. Transducers were placed at pre-oxygenator, post-oxygenator and distal arterial line (post-filter) positions. Flow probes were also placed both pre and post filter. The injections were made at three flow rates, hypothermic and normothermic temperatures, and with the purge line in both the opened and closed positions. Six injections were done at each of the 12 experimental conditions.

Results:

Results demonstrated that GME in the arterial line increased with increasing temperature and flow rate. The Capiox RX15 had the least GME in the arterial line at all experimental conditions. The KIDS D101 had the largest pressure drop and the lowest retention of hemodynamic energy, while the Capiox had the lowest pressure drop (Figure 1). All of the oxygenators had a similar amount of "stolen" blood flow and it was consistently under 10% of the total flow reaching the patient.

Conclusions:

This study demonstrated that the Capiox RX15 circuit was the most efficient pediatric circuit tested in terms of removing GME from the CPB circuit. The pressure drop and THE of the Capiox, the Quadrox-i and the Quadrox-i with arterial filter were all similar.

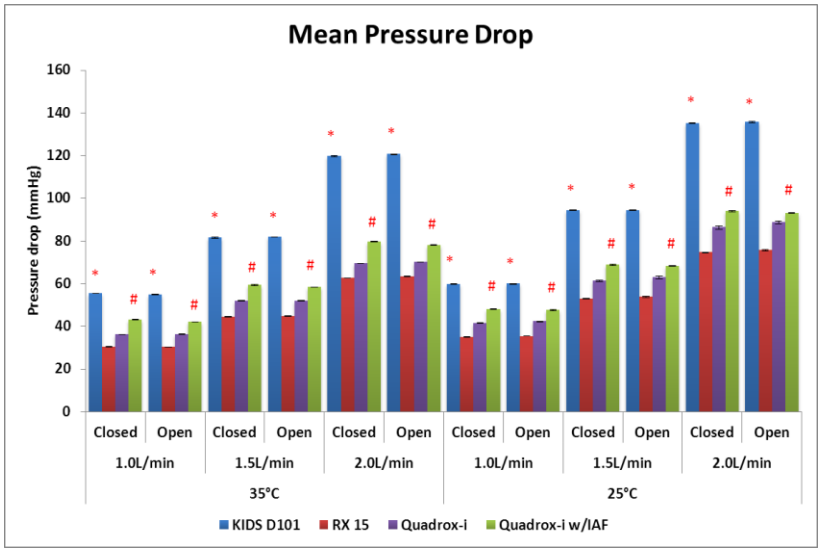

Figure 1. Mean pressure drop across all four oxygenators at normothermic and hypothermic conditions. * p<0.001: KIDS D101 vs. other three oxygenators; # p<0.01: Quadrox-i with IAF vs. Capiox RX15 and Quadrox-i.

P5. Is It Important the Cerebral NIRS (Near Infrared Spectroscopy) Monitoring during Pediatric Aortic Coarctation and/or Arch Repair?

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Objective:

Aortic coarctation repair has ischemic risk for the distal tissues after cross-clamp at. Complex aortic arch repairs have greater risk. NIRS is a noninvasive method used to measure regional tissue oxygenation continuously and may permit assessment of changes in regional cerebral perfusion in real time.

Methods:

Between the May 2012 to date, we operated 46 pediatric patients who had aortic arch abnormalities; aortic coarctation (n=32), IAA (N=11, 4 of them with VSD-ASD) and DAA (double aortic arch, n=3). We used the NIRS monitoring to real-time changes in cerebral regional oxygenation (rSO_2) in patients undergoing aortic coarctation repair and/or arch repair routinely. Our data pool allowed us to analyze the changes in rSO_2during aortic coarctation repair for three pediatric age groups (neonates (≤30 days, infants <1 year, and children ≥2yrs). Data for rSO_2 were analyzed for each age group according to before, during and after cross-clamp. Antegrade cerebral perfusion via innominate artery was used to repair of complex aortic arch pathologies at 20-22° C.

Results:

46 patients were available for analysis (22 neonates, mean: 6.5days; 18 infants, mean age: 5.2mos and 6 children, mean age: 4.5yrs). The regional oxygenation below the cross clamp (rSO_2-S) declined significantly in all three age groups, but the decrease in neonates and infants was significantly greater than in the older children($p<0.05$). Four of cases (including one IAA-VSD case) had low (<35-40) NIRS values during X-Clamp time. 4 of them had mild and two of them had severe seizures but not recurrence at late postoperative period. As a result of EEG and MRI appliance to these patients, there was no specific lesion at brain tissue. The monitoring period were 3 months averagely. During this period, there was no neurologic deficit, new attacks and no need to pharmacological therapy including last severe one.

Conclusions:

NIRS (rSO_2) value provides real-time threshold data of regional cerebral oxygenation under the aortic cross-clamp. While the $SatO_2$ changes were minimal at the same time, the decline in rSO_2 during aortic cross-clamp was rapid and large in most neonates and young infants <1 year which suggests impairment of regional cerebral perfusion presumably because of a lack of adequate collateral circulation to the monitored regional tissue, and children >1 year, probably reason of that they had time to develop a more adequate collateral circulation around the aortic obstruction ($p<0.035$). Low NIRS values (<40) may predict neurologic morbidity early perioperative period especially after X-clamping. Such a complex cases like these instances, antegrade cerebral perfusion can safely be used to prevent major brain damages.

P6. Is There a Difference Between Pulsatile and Nonpulsatile Perfusion Mode According to Cyanotic or Not as Perioperative Parameters in Pediatric Cardiac Surgery with CPB?

Yeliz Koçoğlu[1,2] , Atıl Gürsoy[1,3] , Tijen Alkan-Bozkaya[1], Halil Türkoğlu[1], Atıf Akçevin[1]

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Objective:

We explored that is there a difference at perioperative hematologic and lactate parameters (preoperative and post CPB) and what is the effect of cyanosis on these values at a clinical setting in this study.

Methods:

We chose a similar group who had undergone CPB for congenital heart defects from the patient's data pools at the 2 different centers. In each group, there were 20 patients. Their demographic data (age, BSA, weight) and their perioperative parameters (X-clamp, CPB time and flow rate) were identical statistically. We compared to our results according to the perfusion modes (Group P vs Group NP).

Results:

We found that there was no difference in the hematological variables (Hb, Htc, perioperative usage of blood and products and ultrafiltration). But we found that the difference between the on-off CPB- lactate levels were lower in pulsatile group significantly in both cyanotic and acyanotic subgroups. (Cyanotic subgroup - pulsatile: 0.43±0.27 vs nonpulsatile: 1.26±0.21; p=0,019 and acyanotic group-pulsatile: 0.33±0.11 vs nonpulsatile: 1.08±0.12; p=0,045). All patients survived to hospital discharge, and they were uneventful clinic outcome in early postoperative period.

Conclusions:

Lactate levels are important predictors for clinical outcome. When compared to 2 different perfusion modes according to the lactate levels, the expectation of good clinical outcome would be higher in pulsatile group.

P7. Novel Pulsatile ECLS System with Superior Hemodynamic Energy

Shigang Wang[1], Sunil Patel[2], Allen R. Kunselman[3], and Akif Ündar[1,4,5]

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Objective:

The objective of this study is to evaluate iLA membrane ventilator and icor diagonal pump in terms of trans-membrane pressure gradient and hemodynamic energy delivery under non-pulsatile and pulsatile modes in a simulated adult ECLS system. Surplus hemodynamic energy (**SHE**) can be generated only under pulsatile flow and maintains better microcirculation and vital organ perfusion.

Methods:

The ECLS circuit consisted of i-cor diagonal pump and console (Xenios AG, Heilbronn, Germany), iLA membrane ventilator (Xenios AG, Heilbronn, Germany), 3/8-in ID x 160 cm of arterial tubing, and 3/8-in ID x 140 cm of venous tubing. A CAPIOX RW30 venous/cardiotomy reservoir (Terumo Corporation, Tokyo, Japan) severed as a pseudo patient. The circuit was primed with lactated ringer's solution and fresh whole blood (hematocrit 35%). All trials were conducted at flow rates of 1-3 L/min (1 L/min increments) under room temperature. The pulsatile flow settings were set at pulsatile widths of 150ms-250ms (50ms increments), and differential speed values of 500 rpm - 4500 rpm (1000 rpm increments). The post-clamp pressure was maintained at 150 mmHg during all trials. Flow and pressure data were collected using a custom-based data acquisition system.

Results:

The oxygenator pressure drops were 5.0 mmHg - 15.8 mmHg at flow rates of 1 L/min to 3 L/min, respectively. Under pulsatile mode with increased differential speed values, SHE and total hemodynamic energy levels increased (**Figure 1**). No SHE generated under non-pulsatile mode. Figure 2 presents the pre-cannula flow waveforms under pulsatile mode with variable differential speed values at 2 L/min.

Conclusions:

The novel iLA membrane ventilator has a lower trans-membrane pressure gradient and allows more hemodynamic energy delivered to the patient. Pulsatile flow generates more SHE than non-pulsatile flow. Pulsatile settings have a significant impact on the quality of pulsatility.

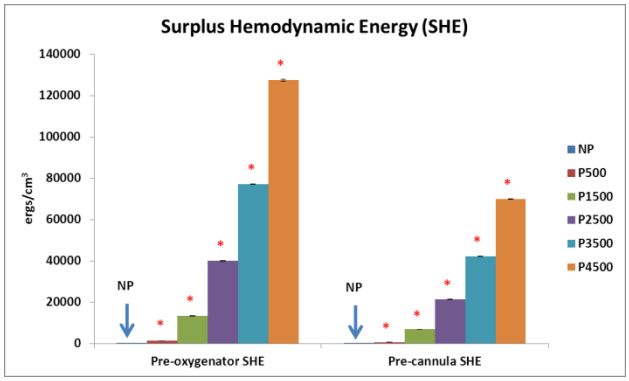


Figure 1. Surplus hemodynamic energy (SHE) at the pre-oxygenator and pre-cannula sites under non-pulsatile (NP) and pulsatile (P) mode with varying differential speed values (P500 - P4500) at 2 L/min. * P <0.01, NP vs. P.

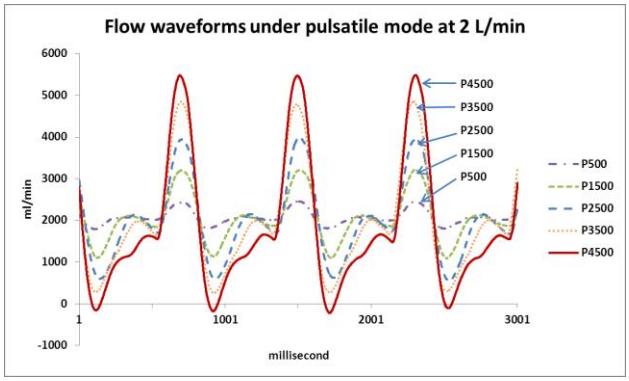


Figure 2. Pre-cannula flow waveforms at 2 L/min under pulsatile mode with variable differential speed values (P500 - P4500) and frequency 75 bpm.

P8. Hemodynamic Evaluation of Novel i-cor® Pulsatile MCS System during Various Cardiac Arrhythmias: In Vitro Pilot Study

***[£]Sunil Patel, *Shigang Wang, [£]Dennis Chang, *Linda B. Pauliks, MD, MPH, [‡]J. Brian Clark, MD, [†]Allen R. Kunselman, and [*‡§]Akif Ündar**

**Pediatric Cardiovascular Research Center, Department of Pediatrics, [£]Pediatric Cardiology Division, [†]Public Health Sciences, [‡]Surgery, Penn State Milton S. Hershey Medical Center, Penn State Hershey College of Medicine, Hershey, PA; and [§]Bioengineering, College of Engineering, Pennsylvania State University, University Park, PA, USA*

Objective:
Mechanical circulatory support (MCS) is frequently used as a rescue for therapy-refractory cardiac arrhythmias. It is unclear how intermittent arrhythmias would influence hemodynamics during pulsatile MCS when it is used in the synchronized mode. This in-vitro study evaluated the effect of simulated arrhythmias on hemodynamics during R-wave triggered pulsatile MCS with the i-cor® kit (Xenios AG, Heilbronn, Germany).

Methods:
The MCS circuit consisted of i-cor® diagonal pump with 3/8-in tubing primed with crystalloid and whole blood at room temperature. Flow and pressure data were collected using a customized data acquisition system. Arrhythmias were simulated using an ECG simulator for R-wave synchronized pulsatile MCS at 4 different flow rates (2.5, 3, 3.5 and 4 L/min). Conditions included ventricular tachycardia, ventricular fibrillation and atrio-ventricular sequential pacing. Each condition was tested at 4 flow rates with 3 different ECG synchronization modes (1:1, 1:2 and 1:3 R-wave synchronization).

Results:
At all flow rates, pulsatile flow with 1:2 synchronization generated optimal surplus hemodynamic energy (SHE) during every condition (ventricular fibrillation or tachycardia and AV-sequential pacing) (**Figure 1**). Maximum pulsatile flow waveforms were achieved at 1:2 synchronization, followed by 1:3 and 1:1 ratios. At higher flow rates, SHE declined and the pressure drop increased independent of arrhythmia condition. **Figure 2** presents pulsatile flow waveforms at 2.5 L/min flow under pulsatile mode with various assist ratios (1:1, 1:2, and 1:3). During rapid AV-sequential pacing, we observed stalling of the system (panel A and C) that seemed to be related inappropriate triggering of pump action by the atrial pacer-spike.

Conclusions:
This in-vitro study demonstrated the feasibility of generating R-wave synchronized pulsatile flow with the novel i-cor® diagonal pump. There was output even during cardiac arrhythmias. In this in-vitro experiment, pump rates around 80/min delivered substantially higher SHE and total hemodynamic energy and corresponded to 1:2 synchronization mode.

Figure 1. Surplus hemodynamic energy (SHE) during pulsatile ECLS at different flow rates with various synchronization modes (1:1, 1:2, 1:3) and different cardiac arrhytmias.

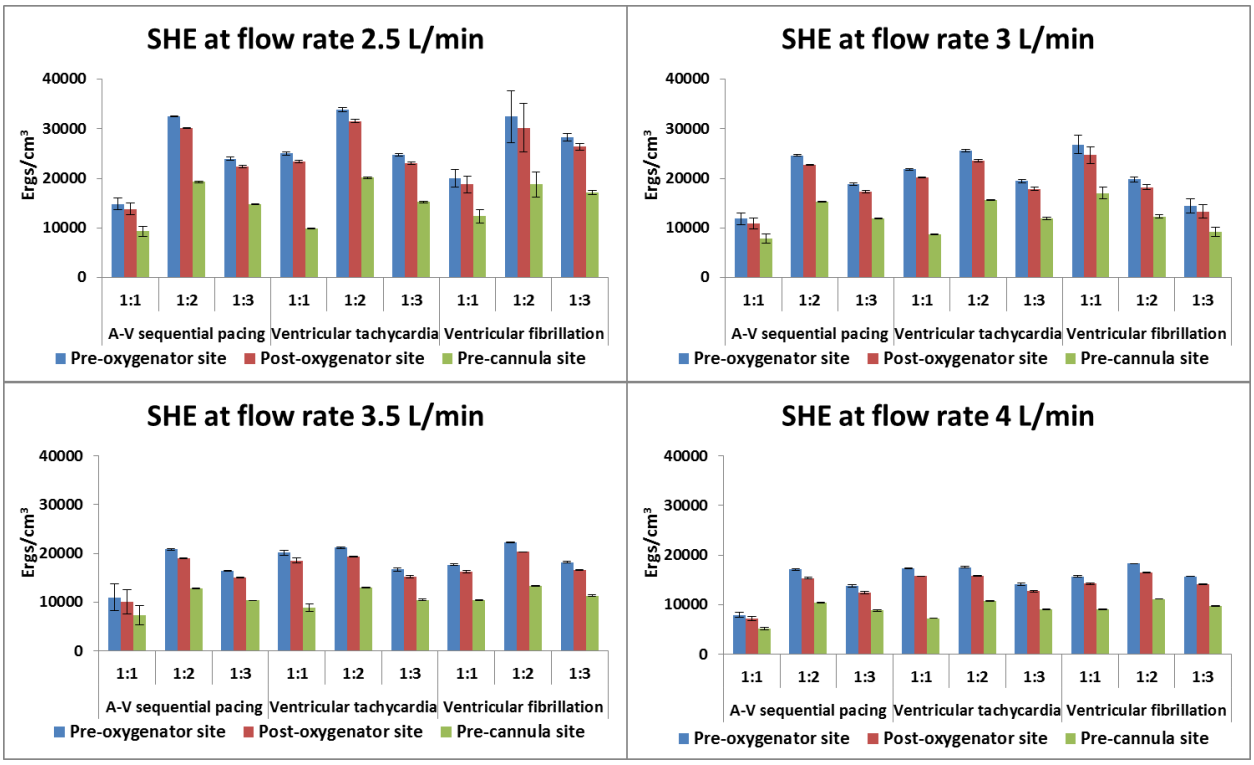
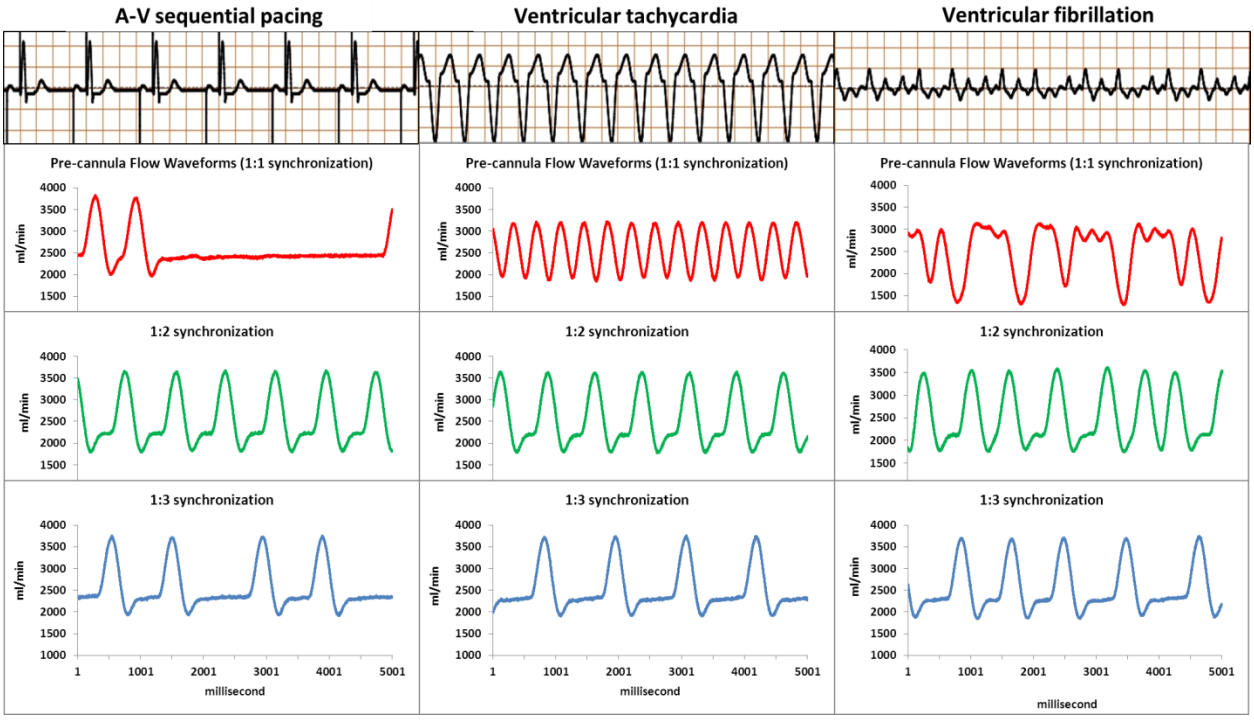


Figure 2. Different cardiac arrhythmia and pre-cannula flow waveforms at 2.5 L/min flow under pulsatile mode with various assist ratios (1:1, 1:2, and 1:3).



P9. Perioperative Cerebral and Renal Perfusion Monitoring with NIRS in Pediatric Patients Undergoing Cardiac Surgery

Arda Özyüksel[1], Tijen Alkan-Bozkaya[1], Pelin Karaaslan[2], Cihangir Ersoy[1], Tuğrul Örmeci[3], Burak Arkan[1], Atıf Akçevin[1], Halil Türkoğlu[1]

Istanbul Medipol University, Dept. of Cardiovascular Surgery[1], Anestesiology[2] and Radiology[3], Istanbul, TURKEY

Objective: Although improvements in short and long term outcomes in cardiac surgery are evident, the postoperative neurological and renal morbidities still remain as significant problems. The utilization of cardiopulmonary bypass (CPB) in pediatric cardiac surgery may lead to impairment of renal functions due to cyanosis, increased cerebral vascular resistance and low cardiac output. In this study, we aimed to continuously monitor the cerebral and renal perfusion by means of near-infrared spectroscopy (NIRS) in patients undergoing pediatric cardiac surgery.

Methods: 20 patients aged less than 2 years who underwent pediatric cardiac surgical procedures were included in the study. Patients were classified into those with cyanotic or not and also complex and simple according to ABC risk stratification. Perioperative regional cerebral and renal oxygen saturation indexes (rSO_2i) were continuously monitored in order to detect the possible cerebral and renal desaturation in the postoperative period for assessment of the risk for adverse outcomes. A NIRS sensor (5100 C, INVOS, MI, USA) was used for monitoring of patients for perioperative and early postoperative period (first 48 hours). Cerebral and renal rSO_2i was recorded by one minute intervals. Database from all patients in each group were collected and analyzed using t-test and chi-square for comparison.

Results: NIRS data was measured perioperatively and early in the postoperative period in 6 stages; I. after induction, II. X-Clamp time, III. CPB termination time, IV. Postoperative fourth hour, V. after extubation and VI. postoperative 48th hour. The data was compared in between the groups. We found that cerebral and renal NIRS values were lower in the complex group significantly (c-NIRS: $p = 0.031$ and r-NIRS: $p = 0.044$). All of cases had postoperatively uneventful neurological follow up. All patients survived to hospital discharge except one patient with hypoplastic left heart syndrome who had undergone Norwood procedure. But there was no clinical and neurologic impairment in the operated patients.

Conclusions: NIRS can be effectively used in patients with complex cardiac pathologies. Both cerebral and renal NIRS monitoring may warn the surgery team in order to take precautions. Very low rSO_2i (<40) may be associated with encountering new hypoxic-ischemic brain lesions seen on postoperative MRI. Patients who had lower cerebral NIRS values must be checked with MRI late postoperatively period.

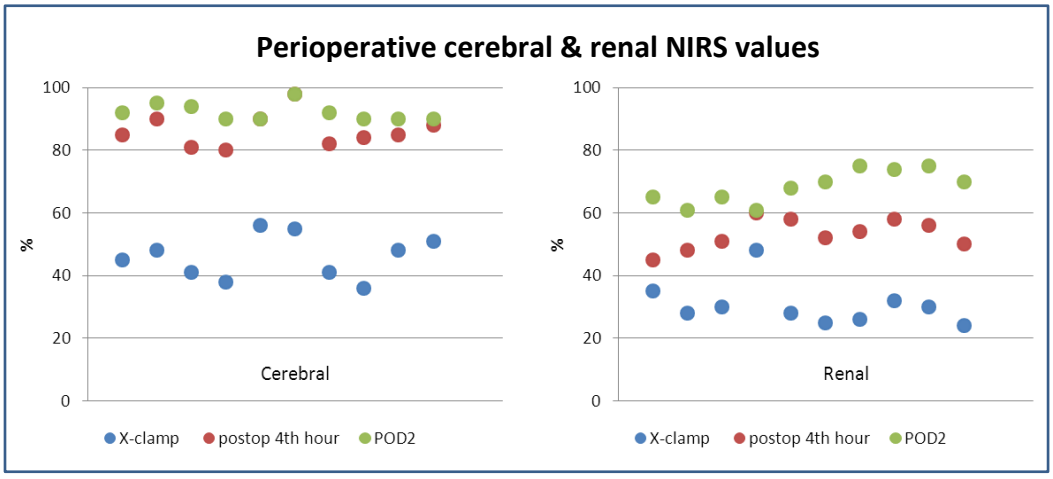


Figure 1. Perioperative cerebral & renal NIRS values.

P10. Comparative Effects of Pulsatile and Nonpulsatile Flow on Plasma Fibrinolytic Balance in Pediatric Patients Undergoing Cardiopulmonary Bypass

Mehmet Ağırbaşlı, †Jianxun Song, †Fengyang Lei, ‡Shigang Wang, §Allen R. Kunselman, ‡**Joseph B. Clark, ‡**John L. Myers, and ‡‡Akif Ündar

Department of Cardiology, College of Medicine, Istanbul, Turkey; Department of Microbiology and Immunology†, Pediatric Cardiovascular Research Center, Department of Pediatrics‡, Public Health Sciences§, Surgery, Penn State Milton S. Hershey Medical Center, Penn State Hershey College of Medicine, Pennsylvania State University, Hershey; and ‡‡Department of Bioengineering, College of Engineering, Pennsylvania State University, University Park, PA, USA*

Objective: In the brain, the components of the fibrinolytic system, tissue plasminogen activator (tPA) and its endogenous inhibitor plasminogen activator inhibitor-1 (PAI-1), regulate various neurophysiological and pathological responses. Fibrinolytic balance depends on PAI-1 and tPA concentrations. The objective of this study is to compare the effects of pulsatile and nonpulsatile perfusion on fibrinolytic balance in children undergoing pediatric cardiopulmonary bypass (CPB).

Methods: Plasma PAI-1 antigen and tPA antigen were measured in 40 children (n = 20 pulsatile and n = 20 nonpulsatile group). Plasma samples (1.5 mL) were collected (i) prior to incision, (ii) 1 h after CPB, and (iii) 24 h after CPB. PAI-1 and tPA levels were measured at each time point.

Results: PAI-1 and tPA levels were significantly increased at 1 h after CPB, followed by a decrease at 24 h. Nonpulsatile but not pulsatile CPB lowered PAI-1 : tPA ratio significantly at 24 h (median PAI-1 : tPA ratio 4.63 ± 0.83:1.98 ± 0.48, P = 0.03, for the nonpulsatile group and 4.50 ± 0.92:3.56 ± 1.28, P = 0.2, for the pulsatile group) (**Figure 1**).

Conclusions: These results suggest that pulsatile flow maintains endogenous fibrinolytic balance after pediatric cardiopulmonary bypass. Further studies are needed to define the clinical significance of these differences.

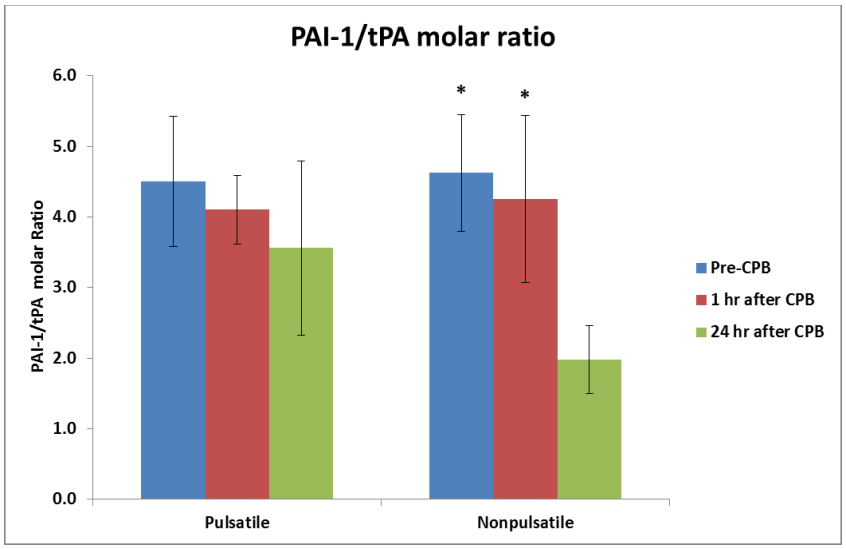


Figure 1. PAI-1 : tPA molar ratio results.

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The list of publications was generated during the past nine international conferences (2005 - 2014)

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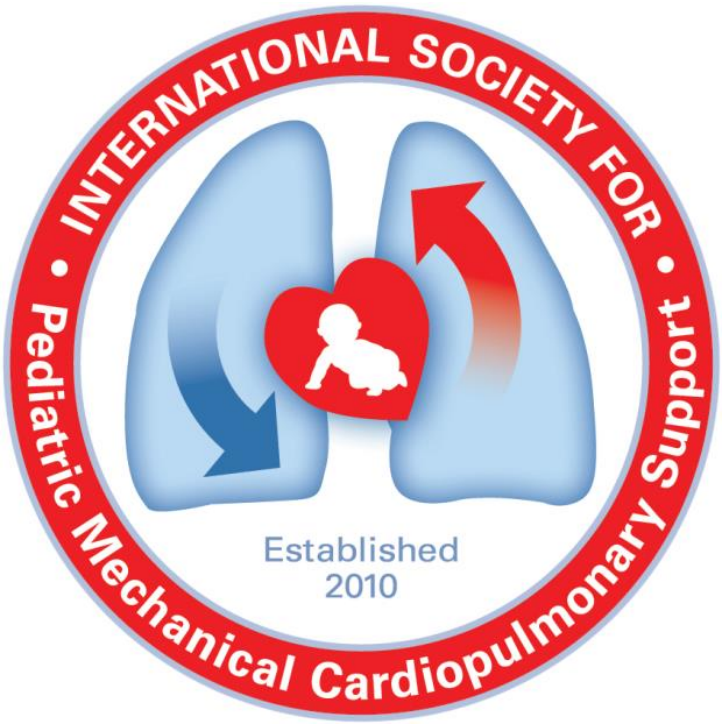

The mission of this society is to focus on the current problems associated with pediatric cardiac patients during and after acute or chronic cardiac support. The society will bring together as many distinguished clinicians, bioengineers, and basic scientists as possible to precisely define current problems and suggest novel approaches and solutions.

Our motto continues to be:

IF THE COURSE OF JUST ONE CHILD'S LIFE IS IMPROVED AS A RESULT OF THIS SOCIETY, WE HAVE REACHED OUR GOAL.

Akif Ündar, PhD, Founder and President

International Society Web Site: http://www.cvent.com/d/7cqc1m