COstatus® Monitoring

- Cardiac Function
- Blood Volumes to Guide Fluid Therapy
- Shunt Identification & Quantification
- Use During Cardiac Support (ECMO, Impella, LVAD)

- Used on more than 700 neonatal, pediatric, & adult patients (0.6-115 kg)
- More than 100 publications (20 full papers)
- Hemodynamic parameters measured at various stages in single ventricle patients
- Largest pediatric single center hemodynamic study - 100 patients
- COstatus® was validated in the OR and multiple human & animal studies versus
  - Thermodilution PA Catheter
  - Direct Fick
  - Perivascular Flowsensors
Most Minimally Invasive, Universal Dilution Method

- Able to be used on patients of any age and any pathology including hypoplastic heart
- Minimally invasive - uses existing arterial & central venous catheters (no need to insert specialized catheter)
- Safe isotonic saline indicator
- No blood loss
- Quick 10 minute test

Neonatal Single Ventricle Patient 2.8 kg

**Courtesy: Dr. Ana Rodrigues & Prof. Manuel Sanchez, Hospital General Universitario Gregorio Marañón Madrid, Spain**

Adult Patient 108 kg

**Courtesy: Prof. Eremenko, Center for Surgery Moscow, Russia**
Schematic of AV Loop with connections to the patient’s existing arterial and CV catheters.
**COstatus® Operation**

**Ultrasound Dilution - Introduced in 1995 [Krivitski NM, ASAIO J, 1995]**
Gold Standard Technology: 150+ papers published in Hemodialysis and ECMO fields

Dilution curve produced by the decrease in ultrasound velocity (UV) of blood by the injection of saline

- UV Blood - 1580 m/sec
- UV Saline - 1530 m/sec

**Extracorporeal AV Loop**
Primed with Normal Heparanized Saline

- Priming Volume:
  - Adult/Pediatric - 5.3 mL
  - Neonatal - 2.4 mL

Connects to existing arterial and venous catheters

**Pump**
- Operates for 6-11 minutes (2-3 injections)
- Pump Flow Rate 8-12 mL/min

**Sensors**
- Record
  - Injection volume, time and quality of injection, blood properties, and dilution curves
- Detect
  - Bubbles and obstruction (clotting or kinking)

**Measurements**
- 2-3 Injections of isotonic saline into the AV Loop (0.5 -1 mL/kg per injection with a maximum of 30 mL)
Other Pediatric/Neonatal CO Monitoring Techniques

ULTRASOUND CARDIAC OUTPUT MONITOR (USCOM):
USCOM is a noninvasive cardiac output monitor system that uses continuous-wave Doppler ultrasound. There have been many validation studies performed with this technology in pediatrics and neonates yielding variable results. While many studies report good correlation to the reference technique (Doppler or thermodilution) [1-3], there are several studies that show disagreement between them [4-6]. Additionally, the aortic and pulmonary valve diameters used in the calculation of cardiac output by USCOM are based on published normal cardiac dimensions [7]. In children or infants with non-normal anatomy, the dimensions used may be incorrect leading to inaccuracies in the calculated cardiac outputs [5].

BIOREACTANCE (NICOM):
NICOM is a noninvasive device for monitoring continuous cardiac output using transthoracic bioreactance. In comparisons to echocardiography in pediatric and neonatal patients, large percent errors and wide limits of agreement dissuaded authors from recommending the use of this device for accurate cardiac output [8-10]. It was instead suggested that this could be used as a trending tool for continuous cardiac output [8, 10].

DOPPLER ECHOCARDIOGRAPHY:
The use of Doppler in a suprasternal approach in pediatrics for cardiac output measurements has been reported in 9 comparison studies [11]. In this review paper, the bias was generally less than 10%, but varied considerably. In one study, the discrepancy between Doppler and thermodilution measurements was more than 25% in 1/4 of the patients [12]. The errors in this measurement technique are known and include obtaining correct measurement of the aortic cross-sectional area as well as operator dependency in the angle of insonation. This method would be best used to track changes in cardiac output rather than absolute value [11].

REFERENCES
Bibliography: COstatus® References

PART I: CARDIAC OUTPUT

CARDIAC OUTPUT VALIDATIONS/COMPARISONS: CLINICAL STUDIES AND METHODOLOGY


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CARDIAC OUTPUT VALIDATIONS/COMPARISONS: ANIMAL MODELS


CARDIAC OUTPUT VALIDATIONS/COMPARISONS: ANIMAL MODELS CONT.


PART II: SHUNTS

SHUNT IDENTIFICATION: METHODOLOGY


Krivitski N, Kislukhin V, Thuramalla N, “Identification of Shunts based on the Shape of the Dilution Curve,” 3rd Congress of European Academy of Paediatric Societies (EAPS), Copenhagen, Denmark, Oct. 23-26 2010, Poster Presentation #121. (Transonic Reference # CO8042)


SHUNT IDENTIFICATION: PEDIATRIC AND NEONATAL CLINICAL STUDIES


Marr B, “Can Ultrasound Dilution (UD) Identify and Qualify the Type of Shunt in Neonates with Patent Ductus Arteriosus (PDA)?” Pediatric Critical Care Colloquium, Pittsburgh, PA, May 15-17, 2010. (Transonic Reference # CO8026A)


SHUNT IDENTIFICATION: PEDIATRIC AND NEONATAL ANIMAL MODELS


PART III: SINGLE VENTRICLE

SINGLE VENTRICLE: THEORY AND CLINICAL STUDIES


PART IV: BLOOD VOLUMES

BLOOD VOLUMES: PEDIATRIC AND NEONATAL CLINICAL STUDIES


Ostrowicki R et al, “Effect of Furosemide on Cardiac Index and Circulating Blood Volumes in Pediatric ICU Patients,” Pediatric Critical Care Colloquium, Pittsburgh, PA, May 15-17, 2010 (Transonic Reference # CO8027A)


Eremenko AA and Safarov PN, “Central blood volume index and total end-diastolic volume index as indicators of cardiac preload,”Abstract # 312, Critical Care Medicine, A83, Vol. 35 Supplement 12, Dec 2007. Poster Presentation at the SCCM 37th. Critical Care Congress, Feb 2-6, 2008, Hawaii, USA.


BLOOD VOLUMES: PEDIATRIC AND NEONATAL ANIMAL MODELS


Bandt C et al, “Effects of Norepinephrine on Dynamic versus Static Variables of Fluid Responsiveness during Hemorrhage and after Resuscitation in a Pediatric Model,” Poster Presentation: Pediatric Cardiac Int. Care Soc 2010, Dec 8-11 2010, Miami Beach, FL, USA. (Transonic Reference # CO8116A)
