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Title: Variation in Periprocedural Management in the Congenital Cardiac Catheterization Laboratory: A Multinational PICES Survey
Category: Pediatric

Authors: Brent Gordon, Loma Linda Univ. Children's Hosp, United States; Nathaniel Taggart, Mayo Clinic, United States; Gareth Morgan, Evelina Children's Hospital, United Kingdom; Bryan Goldstein, Cincinnati Children's Hospital Medical Center, United States

Background: The complex nature of congenital heart disease (CHD) has delayed the establishment of management standards for periprocedural cardiac catheterization practices. We sought to describe periprocedural practice variation among providers performing cardiac catheterization in children and adults with CHD.

Methods: A web-based survey (surveymoney.com) was distributed to pediatric and congenital interventional cardiologists. Respondents were queried on their training, practice setting, years in practice, and case volume. Clinical questions focused on periprocedural strategies (antibiotic usage, post-procedure chest radiograph, echocardiogram, electrocardiogram, time of discharge, and first follow up visit) in six interventional scenarios: device closure of patent ductus arteriosus and atrial septal defect, pulmonary balloon valvuloplasty, balloon angioplasty for unilateral pulmonary artery stenosis, stent placement for coarctation of the aorta, and transcatheter pulmonary valve implantation.

Results: Sixty-one pediatric and congenital interventional cardiologists responded to the survey (80% in the United States). Twenty (33%) worked in a public medical institution and 56% worked in a freestanding children's hospital. Twenty-one percent had been in practice for <5 years and 39% for >15 years; two-thirds completed a 4th year in interventional cardiology. Median number of total cases performed was 200/year (IQR 145-255); median number of interventional cases was 110/year (IQR 70-150). Responses surrounding prophylactic antibiotic therapy for device implantation and utilization of post-procedure imaging suggested significant variation in management. Respondents identified education gained in training, rather than manufacturer guidelines or device trial protocol, as the most important factor in dictating periprocedural practice.

Conclusion: In this survey of pediatric and congenital interventional cardiologists, we identified considerable variation in periprocedural management. Future quality improvement efforts are necessary to reduce practice variability and identify "best practices" in periprocedural management of patients with CHD undergoing cardiac catheterization.

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Brent Gordon: This author has nothing to disclose.
Nathaniel Taggart: This author has nothing to disclose.
Gareth Morgan: This author has nothing to disclose.
Bryan Goldstein: This author has nothing to disclose.

03-02

Title: Effect of pulmonary artery angioplasty on exercise capacity and symptoms in children and adults with unilateral proximal pulmonary artery stenosis.

Category: Pediatric

Authors: Gurumurthy Hiremath, University of California (San Francisco), United States; Lakshmi Nagaraju, Cleveland Clinic, United States; Phillip Moore, University of California (San Francisco), United States; Athar Qureshi, Baylor College of Medicine, Texas Children's Hospital, United States; Lisa Bergersen, Children's Hospital, Boston, United States; Lourdes Prieto, Cleveland Clinic, United States; Taggart Nathaniel, Mayo Clinic, United States; Jeffery Meadows, University of California (San Francisco), United States

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Background: Pulmonary blood flow maldistribution (PBFM) resulting from unilateral pulmonary artery (PA) stenosis leads to decreased ventilatory efficiency, dyspnea, and decreased exercise capacity; and patients often underestimate their exertional limitations. Because most pulmonary vascular growth occurs in early childhood, there is debate about whether intervention later in life is warranted. We hypothesized that PA angioplasty/stent placement leads to improvement in PBFM, exercise capacity, ventilatory efficiency (as measured by V_E/VCO_2 slope) & symptoms.

Methods: Multi-institutional, prospective cohort study. Patients >10 years of age with biventricular circulations, unilateral proximal PA stenosis & PBFM of $\geq 10\%$ (from normal 55/45% pattern), undergoing PA angioplasty/stenting were enrolled and underwent pre/post PA intervention pulmonary perfusion scans and exercise testing with assessment of peak VO_2 , O_2 pulse, V_E/VCO_2 and dyspnea scores.

Results: Enrollment is ongoing, with 13 patients enrolled. Median age is 20 (11 – 66) years. Most (54%) were 'asymptomatic' and were referred for abnormal imaging. At baseline, patients demonstrated decreased exercise capacity with a decreased percent-predicted peak VO_2 , peak work, & percent predicted peak O_2 pulse. Balloon angioplasty or stent placement (85%) was successful in all patients without serious procedural complications. The median increase in vessel diameter was 6.2 (2-9.5) mm, and baseline PBFM improved significantly from 36% (10 – 62%) to 7% (0 – 28%). There were statistically significant improvements in exercise capacity, with improved peak VO_2 (63% predicted to 83%, $p = 0.04$), peak work (107 to 132 watts, $p = 0.02$) & peak O_2 pulse (80% predicted to 93%, $p = 0.04$). Ventilatory efficiency also improved significantly with a decrease in V_E/VCO_2 slope from 33(26-42) to 28 (20-30), $p = 0.027$. There was a trend towards improvement in dyspnea scores (from 1.5 to 0, $p = 0.12$).

Conclusion: Balloon angioplasty/stent placement improves PBFM, and improvement in PBFM is associated with significant improvements in exercise capacity, ventilatory efficiency and a trend toward improved dyspnea with exercise.

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Gurumurthy Hiremath: This author has nothing to disclose.
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Lourdes Prieto: This author has nothing to disclose.
Taggart Nathaniel: This author has nothing to disclose.
Jeffery Meadows: This author has nothing to disclose.

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Title: Radiation dose reduction capabilities of a next generation pediatric imaging system

Category: Pediatric

Authors: Luke Lamers, University of Wisconsin Health System, United States; Martine Moran, University of Wisconsin Health System, United States; Jenna Smith, University of Wisconsin Health System, United States; John Hokanson, University of Wisconsin Health System, United States

Background: Radiation exposure occurs with any x-ray directed pediatric catheterization. Technologies and imaging techniques that limit dose while preserving image quality directly benefit patient care.

Methods: Radiation dose data was retrospectively obtained for patients < 20 kg who underwent patent ductus arteriosus (PDA) closure by a single cardiologist on a standard imaging system (Group I, $n = 11$) or a next-generation pediatric imaging system, Q.zen - Siemens

	Group 1 (ALLURA FD 10/10 – 2007) (N=11)				Group 2 (Q,Zen - 2014) (N=10)				p-value
	Mean	SD	Median	Range	Mean	SD	Median	Range	
Age (months)	22.4	16.8	16.0	3-55	25.6	18.3	24.0	0-58	0.7244
Weight	9.9	4.3	9.5	4.5-16.8	10.9	4.9	10.1	3.5-18.9	0.6726
# Angiograms	4.3	1.3	4.0	2-6	3.3	0.7	3.0	2-4	0.0567
Total Fluoroscopy Time	11.0	5.1	9.3	4.7-22.5	8.5	2.2	8.5	5.6-12.4	0.2451
Air kerma (mGy)	126.2	108.6	86.0	44.0-426	32.1	12.1	27.5	24-62	0.0002
DAP ($\mu\text{Gy m}^2$)	857.7	703.3	568.0	239-2639	218.5	92.3	199.0	104-402	0.0003

Healthcare, Forchheim, Germany (Group 2, n = 10) in combination with air gap and removal of anti-scatter grids. Group 2 radiation dose data was compared to published benchmarks.

Results: Patient demographics, procedural technique, closure devices and fluoroscopy time were similar. PDA minimal diameters were similar: Group 1 – 2.2 mm (1-4.5), Group 2 – 2.9 mm (1.2-6) (p-value 0.2). Air kerma and DAP decreased by 65-70% (Table 1). The average number of angiograms approached statistical significance (p value = 0.06); therefore, analysis of covariance (ANCOVA) was conducted that confirmed significantly lower dose measures for Group 2. This degree of dose reduction was similar when Group 2 patient data (Kerma 28 mGy, DAP 199 $\mu\text{Gy m}^2$) was compared to the published benchmarks of Ghelani et al. for PDA closure in patients < 1 year old (Kerma 76 mGy, DAP 500 $\mu\text{Gy m}^2$ - JACC Cardiovascular interventions 2014;7:1060-9).

Conclusion: This is the first clinical study documenting the radiation dose reduction capabilities of a next-generation pediatric imaging platform. The benefit of this dose reduction will be seen in patients exposed to extensive cumulative radiation during complex catheterization procedures.

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Luke Lamers: This author has nothing to disclose.
Martine Moran: This author has nothing to disclose.
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Title: Revascularization and balloon angioplasty for the treatment of left innominate vein obstruction related chylothorax after congenital heart surgery

Category: Pediatric

Authors: Mark Law, The University Of Alabama - Birmingham, United States; Santiago Borasino, The University Of Alabama - Birmingham, United States; William McMahon, The University Of Alabama - Birmingham, United States; Jeffrey Alten, The University Of Alabama - Birmingham, United States

Background: Innominate vein stenosis and thrombosis can lead to the development of chylothorax following cardiac surgery. We report our experience with transcatheter innominate vein revascularization and angioplasty for the management postoperative chylothorax.

Methods: Retrospective review of all patients who underwent transcatheter revascularization and/or angioplasty of innominate vein obstruction following cardiac surgery at a single institution from January 1, 2008 through April 9, 2014. Procedural success was defined as unobstructed venous flow with < 2 mmHg gradient from left subclavian to superior vena cava. All data presented as median (range).

Results: 112 patients had postoperative chylothorax in this time period, 7 (6.3%) of which underwent transcatheter revascularization and dilation of an occluded/stenotic innominate vein. Patient age was 30 days (15 days – 6 years); weight 3 kg (2.7 - 22.2). Diagnosis of innominate vein obstruction was made on postoperative day 8 (2-20). Cardiac catheterization occurred on postoperative day 9 (2-29). Six patients had complete occlusion of left innominate vein and one had severe innominate vein stenosis. Etiology of obstruction was secondary to central venous catheter in five and surgical deep venous manipulation in two. High pressure angioplasty (>12 atmospheres) was required in 6/7 patients. Cutting balloon or stent angioplasty was not employed. Procedural success occurred in all patients. Chest tube output was 63 (12-149) ml/kg/day 24 hours prior to procedure and decreased to 23 (0-64) ml/kg/day two days after procedure (p = 0.01). Chylous effusions resolved 5 (1-16) days post-catheterization. There were no procedural complications or mortalities. Five of seven patients have undergone repeat angiography at 1.7 years (0.5-2.3), all five demonstrating vessel patency and growth.

Conclusion: Innominate vein occlusion/stenosis associated chylothorax is amenable to transcatheter revascularization. This data supports early evaluation and aggressive transcatheter management of innominate vein occlusion in patients with postoperative chylothorax.

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William McMahon: This author has nothing to disclose.
Jeffrey Alten: This author has nothing to disclose.

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Title: Early recurrence of coarctation after aortic surgery is associated with an increased rate of repeat recurrence.

Category: Pediatric

Authors: Matthew Lisi, CHOA/Emory University, United States; Sung In Kim, Emory University Rollins School of Public Health, United States; Dennis Kim, CHOA/Emory University, United States; Robert Vincent, CHOA/Emory University, United States; Christopher Petit, CHOA/Emory University, United States

Background: Recurrent coarctation of the aorta (reCoA) is common following pediatric aortic surgery, and is frequently treated with balloon angioplasty (BA). We sought to identify if early reCoA after aortic surgery predicts an increased rate of future recurrence and intervention.

Methods: We identified 126 patients in the institutional database (2003-14) who underwent BA for reCoA, divided into early (≤ 3 m) and late (> 3 m) recurrence based on the time interval between initial surgery and BA. Immediate BA outcomes were measured using residual % stenosis and pressure gradient. Post-BA recurrence rates and freedom from recurrence at 5 years were compared between the two groups.

Results: Among study patients, reCoA occurred at or before 3 months post aortic surgery (median 2.2 m) in 57.9% and after 3 months (median 5.1 m) in 42.1%. Initial surgery age, complex heart disease prevalence, and type of surgery performed were not significantly different between the two groups. In addition, residual % stenosis ($28.2 \pm 14.5\%$ and $29.0 \pm 12.5\%$ in early and late, respectively) and pressure gradient (7.0 ± 6.8 mmHg and 8.5 ± 9.6 mmHg in early and late, respectively) were similar post-BA.

Repeat intervention was required in 43 (34.1%) patients after BA. Recurrence rate was more than 8-fold higher in the early group (51.5 v. 6.3 per 100 person-years; p < 0.001). At 5 years, 30.7% of patients were free from recurrence in the early group, compared to 75.4% in the late group (p < 0.001) (Figure 1).