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The IMPACT Procedure and How It Has Changed Outcomes for Life-threatening Newborn Conditions

What is an Anesthesiologist doing here? This does not belong here!

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DISCLOSURES

No financial disclosures

OBJECTIVES

- Describe the rationale, and development of the IMPACT approach in neonatal cardiac care.
- Outline the step-by-step process, including patient selection, preprocedural planning, and execution.
- Briefly describe the CHOP experience with the IMPACT procedure

37 weeks fetus with mitral valve dysplasia syndrome

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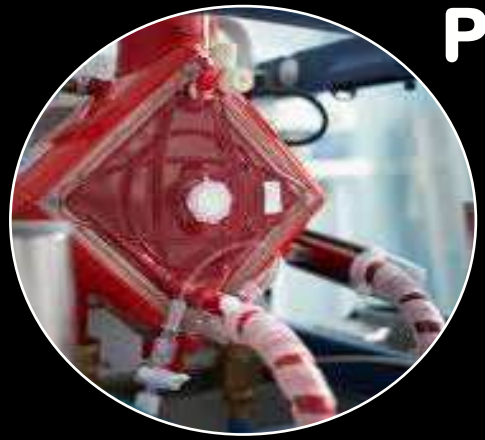
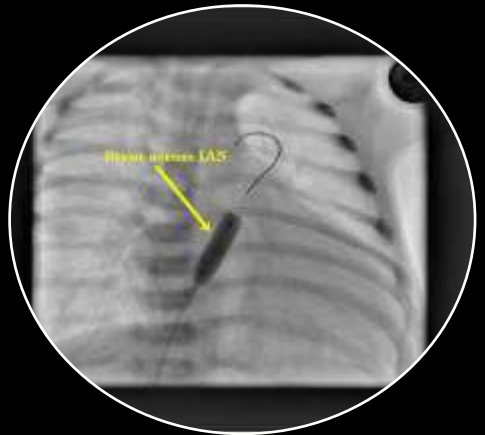
PERINATAL CONCERNS





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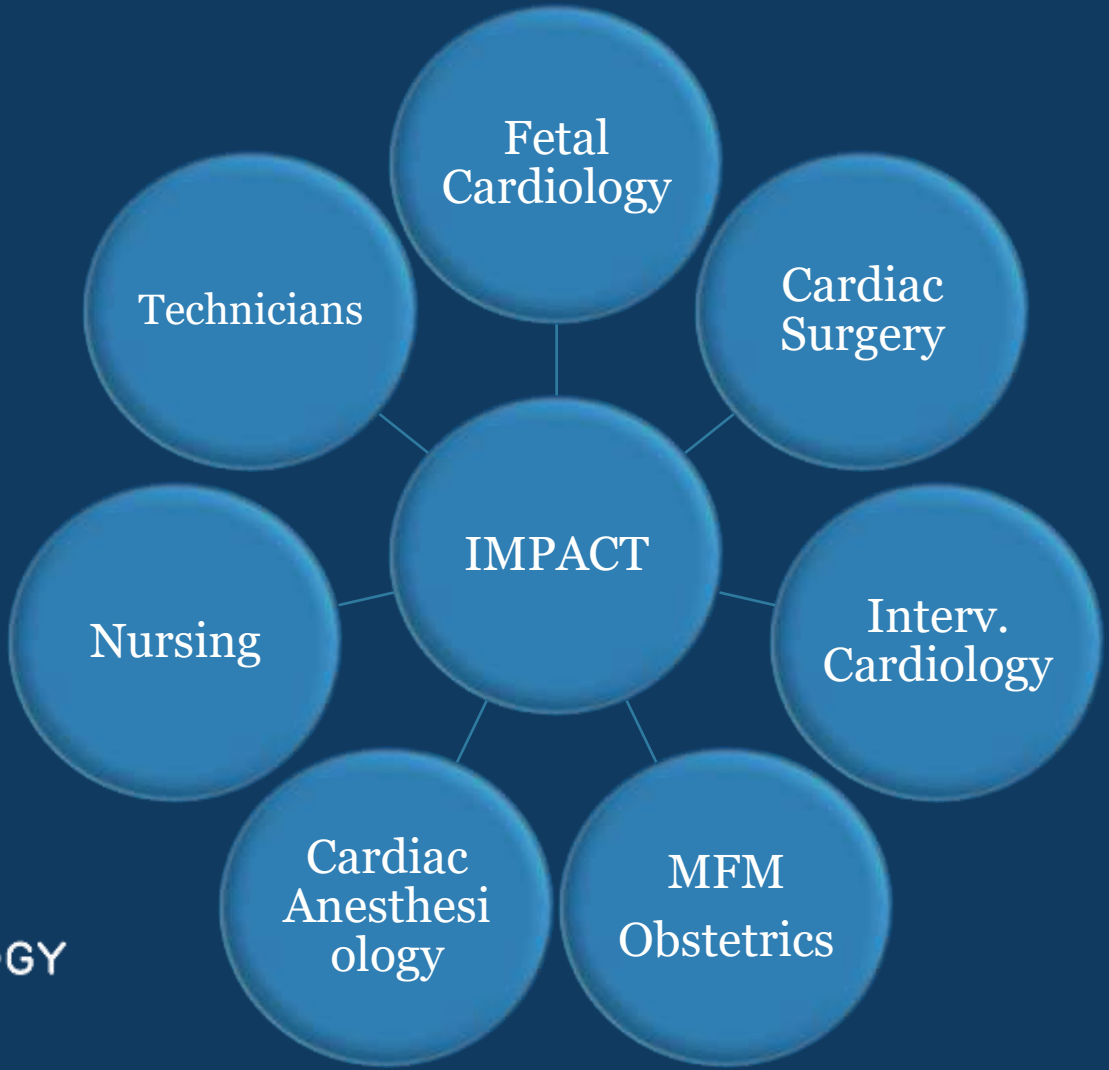
GARBOSE FAMILY SPECIAL DELIVERY UNIT



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Immediate Postpartum Access to Cardiac Therapy

- Multidisciplinary, highly coordinated delivery strategy
- Planned cesarean delivery adjacent to an interventional/surgical suite
- Rapid postnatal evaluation and intervention within minutes of birth

	DEFINITION	PGE?	ACTION	ACCESS	EXAMPLE ANOMALIES/DISEASES*
CLASS Ia	Simple cardiovascular anomaly or disease, requiring delivery in the SDU but no hemodynamic instability anticipated at delivery.	NO	Neonatology to manage delivery.	PIV, no UAC	• LV/RV size discrepancy with suspicion of possible Coarctation of the aorta • AV Canal, balanced • TOF with mild PS (“Pink TOF”) • Benign arrhythmia (non-sustained SVT, no hydrops, no ventricular dysfunction)
CLASS Ib			Neonatology to manage delivery.	UVC+UAC	• Truncus Arteriosus • LV-RV disproportion, with intent to test ductal closure for possible coarctation of aorta
CLASS II	Cardiovascular anomaly or disease of moderate severity, including ductal dependent lesions. Hemodynamic instability is possible, but unlikely and not anticipated at delivery.	YES	Neonatology to manage delivery.	UVC+UAC	• HLHS, no risk factors (open inter-atrial communication, no significant TR, good RV function) • Single ventricle with critical (suspect ductal dependent) pulmonary outflow obstruction (e.g.,tricuspid atresia) • Single ventricle with critical (suspect ductal dependent) systemic outflow obstruction (e.g., Double-inlet LV with arch obstruction) • Coarctation of the aorta • Critical aortic or pulmonic stenosis • TOF with moderate, or severe PS (ductal dependent) • TOF with pulmonary atresia • Pulmonary atresia with intact ventricular septum
CLASS IIIa	Cardiovascular anomaly or disease of important severity with the possibility or likelihood of hemodynamic instability at delivery.	YES	Neonatology to manage delivery in collaboration with Cardiology.	UVC+UAC	• Most transposition of the great arteries (see Class IV category for exception) • HLHS with moderate atrial level restriction, or significant tricuspid regurgitation
CLASS IIIb		NO	Neonatology to manage delivery in collaboration with Cardiology		• Total anomalous pulmonary venous connection (see Class IV category for exception) • Ebstein’s anomaly or tricuspid valve dysplasia with severe tricuspid regurgitation • TOF with Absent Pulmonary Valve Leaflet Syndrome • CHD with evidence for ventricular dysfunction • CHD with evidence for significant AV valve insufficiency • Sustained tachyarrhythmia such as SVT

Padiyath A, Lynch JM, Montenegro LM, Nicolson SC, Nelson O, Szwast AL, Shillingford AJ, Falkensammer CB, Savla JJ, Moldenhauer J, Khalek N, Rychik J. Transitioning from the safety of the womb to the outside world for neonates with life-threatening cardiovascular conditions: The IMmediate Postpartum Access to Cardiac Therapy (IMPACT) Procedure. Pediatr Cardiol. 2025 Jan 20. PMID: 39833300.

	DEFINITION	PGE?	ACTION	ACCESS	EXAMPLE ANOMALIES/DISEASES*
IMPACT (CLASS IV)	Cardiovascular anomaly or disease in which hemodynamic instability is anticipated once separated from placental circulation thus IMmediate Post-partum Access to Cardiac Therapy (IMPACT) is implemented for urgent life-saving care.	YES or NO, DEPENDS ON ANOMALY	Cardiac services including ***cardiac anesthesiology*** and Fetal Heart program to manage delivery and intervention.	UVC+UAC	• HLHS with highly restrictive or intact atrial septum • Fetus with complete heart block requiring pacing • Hydropic fetus with cardiovascular disease • Transposition of the great arteries, intact ventricular septum and evident prenatal restriction of the foramen ovale • Total anomalous pulmonary venous connection with concern of obstruction • Ebstein's anomaly or severe tricuspid valve dysplasia, with suspected pulmonary hypoplasia or anticipated respiratory insufficiency • TOF with Absent Pulmonary Valve Leaflet Syndrome and anticipated respiratory insufficiency

Padiyath A,… Rychik J. Transitioning from the safety of the womb to the outside world for neonates with life-threatening cardiovascular conditions: The IMmediate Postpartum Access to Cardiac Therapy (IMPACT) Procedure. Pediatr Cardiol. 2025 Jan 20. PMID: 39833300.

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CONDITION	ANTICIPATED CLINICAL CONSEQUENCE	FETAL ECHO CRITERIA FOR CANDIDACY	SCHEDULED CESAREAN DELIVERY & PLANNED URGENT INTERVENTION AT BIRTH
Hypoplastic left heart syndrome with intact or highly restrictive atrial septum	Severe hypoxemia at birth due to obstructed left atrial egress and possible pulmonary vasculopathy	○ Intact atrial septum or small foramen ovale opening in the setting of mitral atresia or severe mitral stenosis ○ Pulmonary vein Doppler flow pattern indicating <3:1 anterograde:retrograde flow velocity-time integral ratio	○ Atrial septoplasty via transcatheter procedure with stenting of the atrial septum
Total anomalous pulmonary venous return with obstruction	Severe hypoxemia at birth due to restriction of pulmonary venous return	○ Infra-diaphragmatic connection of total anomalous pulmonary veins, or other forms of anomalous pulmonary venous connection in which drainage appears obstructed	○ Transcatheter stenting with relief of obstruction in decompressing vessel ○ Surgical repair of anomalous pulmonary venous connection
Transposition of the great arteries with restrictive atrial septum	Severe hypoxemia at birth due to inadequate atrial level mixing	○ Appearance of a small foramen ovale, or hyper-mobile redundant septum primum tissue of atrial septum ○ Retrograde flow in the ductus arteriosus which may herald predisposition to development of atrial level restriction ○ Maternal hyperoxygenation provocative testing demonstrating elicitation of atrial restriction	○ Balloon atrial septostomy

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CONDITION	ANTICIPATED CLINICAL CONSEQUENCE	FETAL ECHO CRITERIA FOR CANDIDACY	SCHEDULED CESAREAN DELIVERY & PLANNED URGENT INTERVENTION AT BIRTH
Maternal autoimmune induced complete heart block	Bradycardia with inadequate cardiac output	○ Ventricular heart rate of < 50 bpm ○ Heart rates > 50 bpm but with evidence of ventricular dysfunction or hydrops fetalis	○ Isoproterenol infusion or other inotropic agents as indicated ○ Temporary epicardial pacing wire placement
Pulmonary arterio-venous fistula	Profound hypoxemia due to intra-pulmonary shunting	○ Identification of pulmonary arterio-venous connection with continuous Doppler flow, retrograde flow in ductus arteriosus and cardiomegaly	○ Catheter-based intervention for immediate occlusion of pulmonary arterio-venous fistula
Ebstein's anomaly or severe tricuspid valve dysplasia	Circulatory or respiratory failure	○ Hydrops or prenatal evidence of functional pulmonary atresia and pulmonary insufficiency with "circular shunt"	○ Cardiorespiratory support, including possible ECMO support ○ Strategy for immediate closure of ductus arteriosus

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PATIENT SELECTION

- Patients identified no later than 34 weeks
- Planned C-section delivery in a cardiac OR with a reserved procedural space for the neonate
- Multidisciplinary consultation

- Serial fetal cardiovascular evaluations
- Genetic testing and/or amniocentesis if clinically appropriate
- Weekly case review at the FHP multi-disciplinary conference
- Palliative care consultation for the family
- Social work consultation and logistical planning for relocation
- Order placed by Fetal Heart Team in EHR for the identified procedure
- Evaluation of expectant mother by MFM and Obstetric Anesthesiology
- Obtain procedural and blood transfusion consents
- Discussion of ECMO need, notify ECMO team if indicated
- Cardiac anesthesia consent for neonate
- Cardiac anesthesia team places pharmacy/blood orders in EHR
- Identify coverage for IMPACT during call time
- Final fetal echocardiogram and FHP counseling within 1 week

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Multifunctional procedural suite for the neonate

Operating room for the mother undergoing C-section

Neonate is transported through the short corridor between the operating room and the multifunctional procedural suite

KEY

A. Cardiac anesthesiology attending physicians
B. Fetal heart program attending physician
C. Nurse anesthetist/pediatric cardiac anesthesia fellow
D. Two sets of umbilical vascular access trays
E. Transthoracic echo machine and echocardiography team
F. OR nursing team assisting in resuscitation and access placement
G. Interventional cath table or the OR sterile supply table prepared
H. Cath lab nursing or surgical nursing team on standby to start the procedure
I. Obstetric anesthesiologist
J. Expectant mother having C section in the adjacent OR
K. MFM/obstetric/nursing team for the expectant mother
L. Weighing scale for the neonate
M. Neonate
N. Fetal heart program nurse coordinator
O. ICU ventilator and nitric oxide delivery system
P. Support person for the mother

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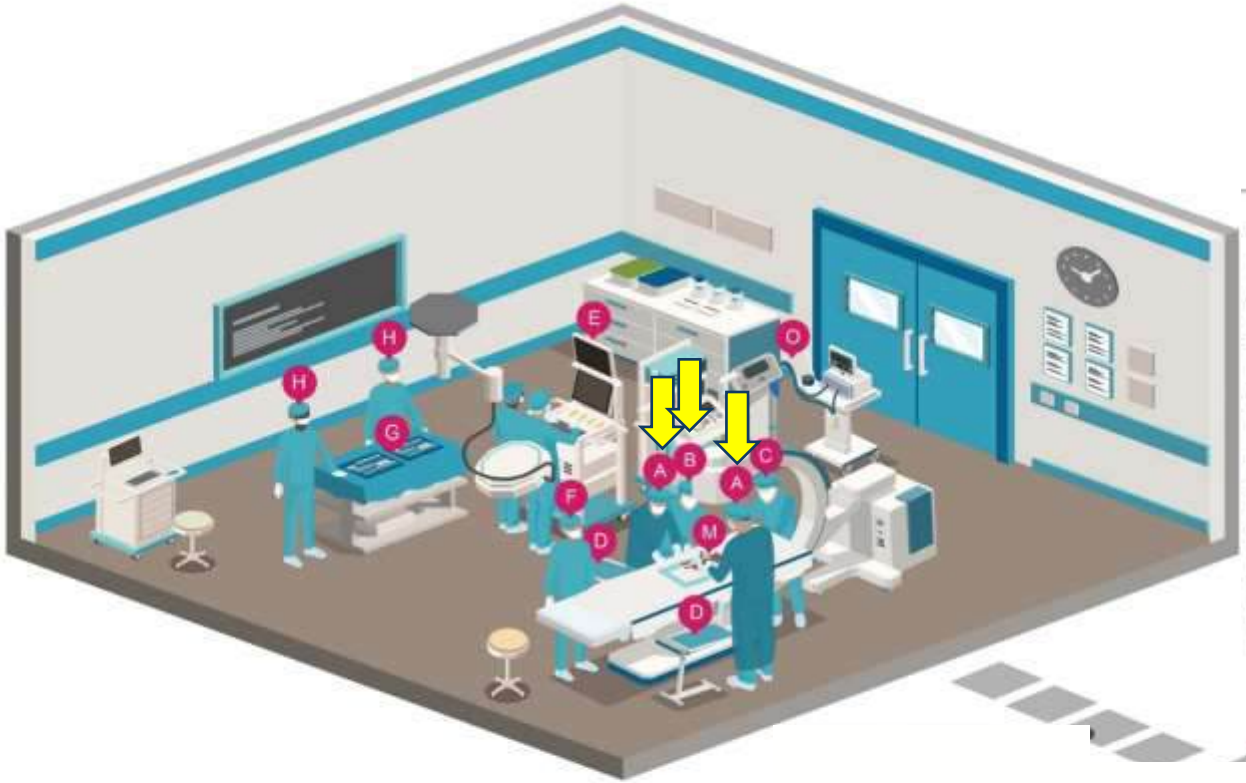

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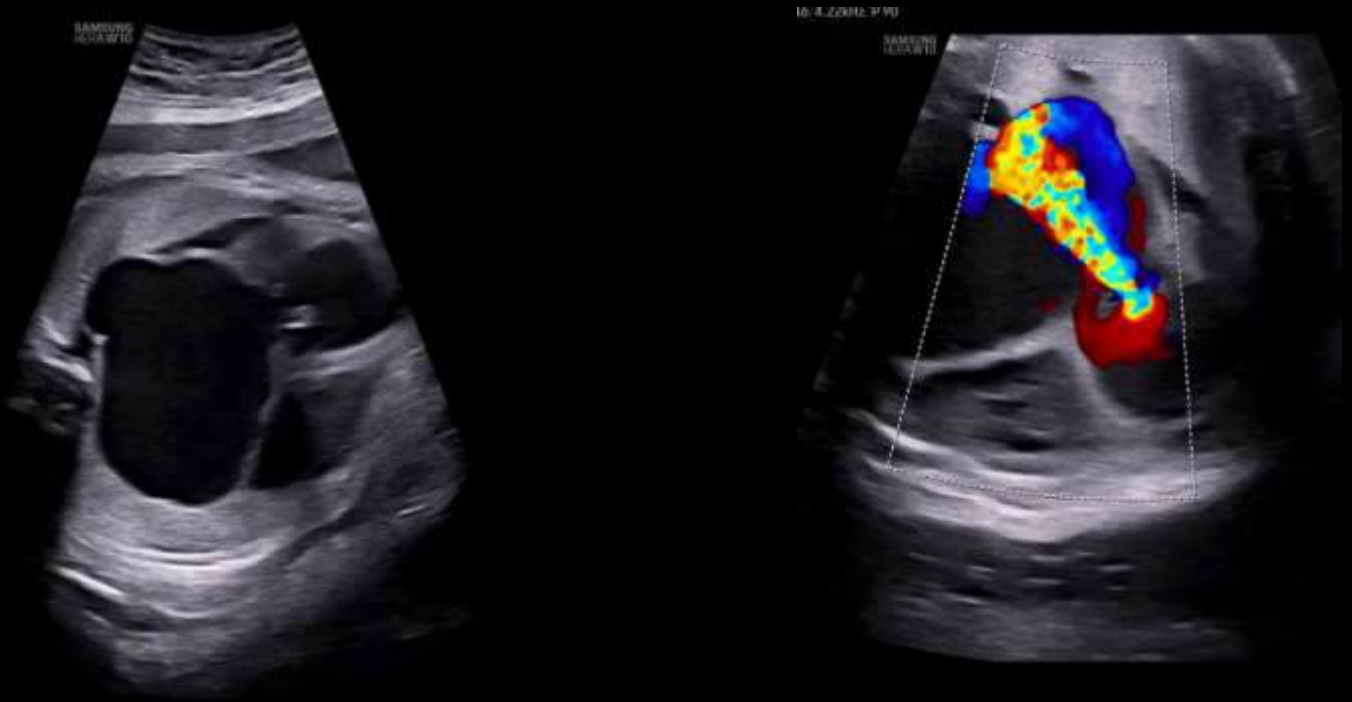
37 weeks fetus with mitral valve dysplasia syndrome



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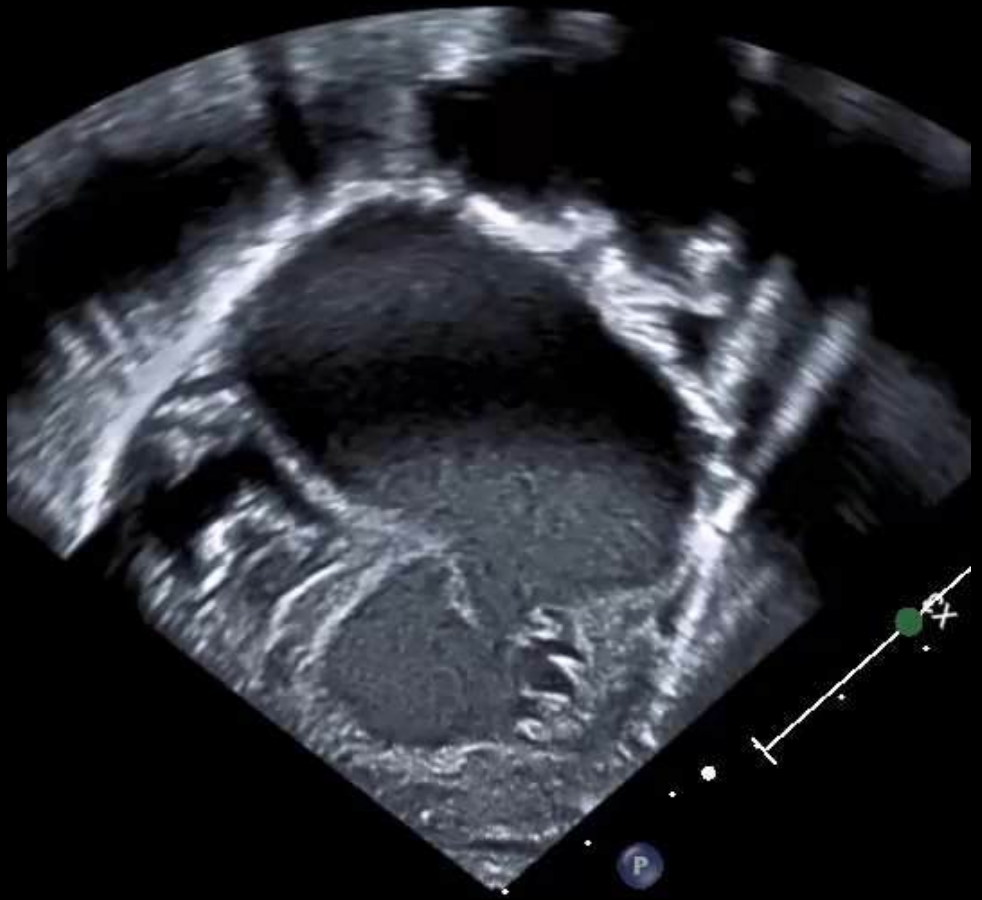
Imaging during IMPACT:

Neonate with mitral valve dysplasia syndrome



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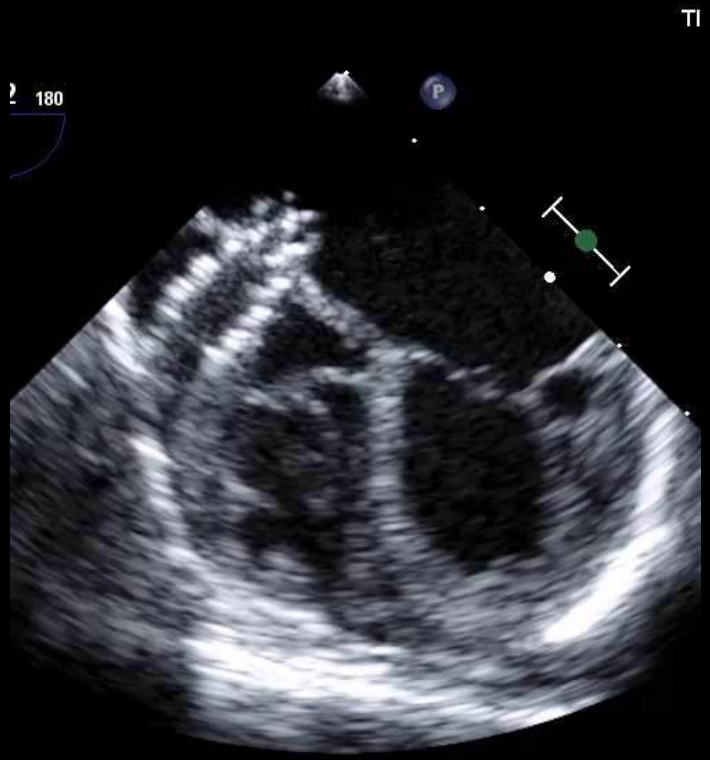
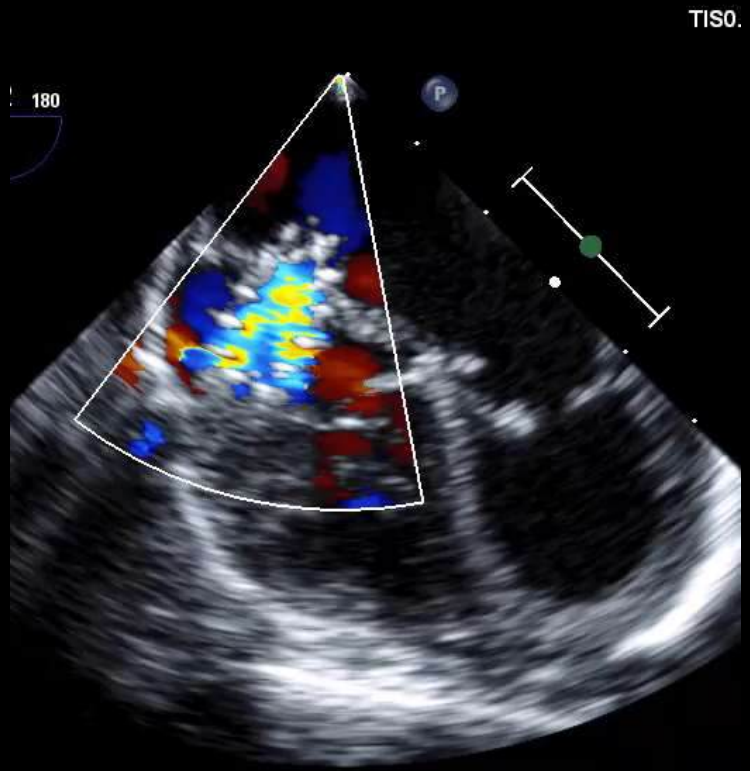
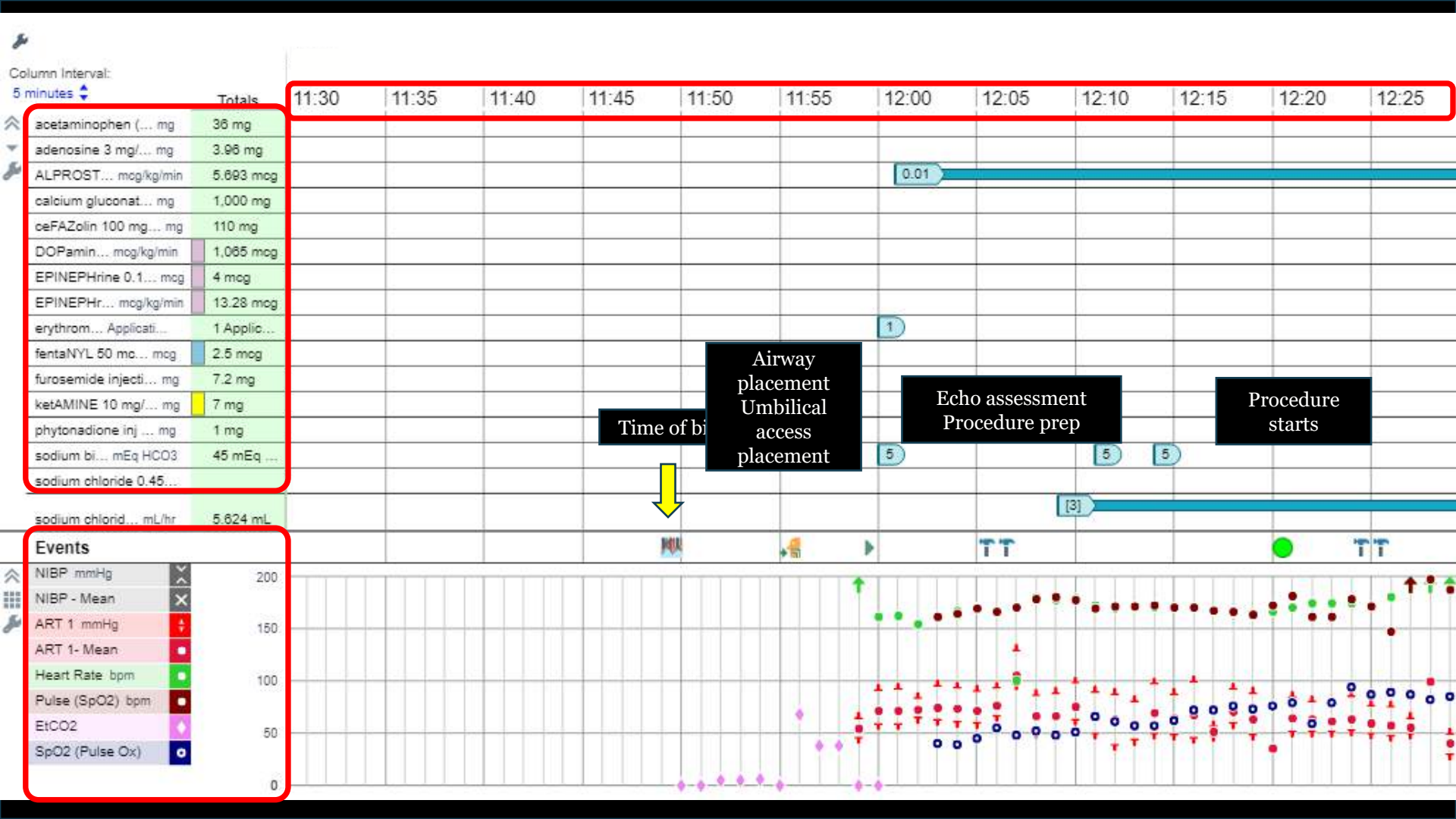
Post Intervention: Neonate with mitral valve dysplasia syndrome






Column Interval:
5 minutes
Totals
acetaminophen (... mg 36 mg
adenosine 3 mg/... mg 3.96 mg
ALPROST... mcg/kg/min 5.693 mcg
calcium gluconat... mg 1,000 mg
ceFAZolin 100 mg... mg 110 mg
DOPamin... mcg/kg/min 1,065 mcg
EPINEPHrine 0.1... mcg 4 mcg
EPINEPHr... mcg/kg/min 13.28 mcg
erythrom... Applicati... 1 Applic...
fentaNYL 50 mc... mcg 2.5 mcg
furosemide injecti... mg 7.2 mg
ketAMINE 10 mg/... mg 7 mg
phytonadione inj ... mg 1 mg
sodium bi... mEq HCO3 45 mEq ...
sodium chloride 0.45...
sodium chlorid... mL/hr 5.624 mL
11:30
11:35
11:40
11:45
11:50
11:55
12:00
12:05
12:10
12:15
12:20
12:25
0.01
1
5
5
5
[3]
Time of bi
Airway placement Umbilical access placement
Echo assessment Procedure prep
Procedure starts
Events
NIBP mmHg
NIBP - Mean
ART 1 mmHg
ART 1- Mean
Heart Rate bpm
Pulse (SpO2) bpm
EtCO2
SpO2 (Pulse Ox)
200
150
100
50
0

IMPACT CHOP EXPERIENCE

- 120 fetuses/neonates have undergone IMPACT since inception to date
- No maternal mortality
- Newborn survival to discharge 65% (varying between 44% to 100% in different pathologies)

Finkelstein, D.M., Houlihan, T.H., Montenegro, L.M., Nicolson, S.C., Moldenhauer, J.S., Gebb, J., Khalek, N., Szwast, A., Smith, E., Coulter, E., Combs, J. and Rychik, J. (2021), OP05.06: Immediate postpartum access to cardiac therapy: outcomes of a coordinated strategy for managing the fetus with severe cardiovascular disease. Ultrasound Obstet Gynecol, 58: 74-74. https://doi.org/10.1002/uog.23967

SUMMARY

- The IMPACT process is a multidisciplinary clinical service
- Designed for fetuses with a high likelihood of neonatal instability
- Planned C-section in an OR with direct access to a procedural suite facilitating rapid cardiac evaluation
- Current strategy of care offered at CHOP, realizing that there may be alternative successful approaches offered at other centers

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Cardiac Anesthesia

Susan Nicolson, MD
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THANK YOU!

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Amanda Shillingford, MD
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Christine Falkensammer, MD
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Jill Savla, MD
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Jack Rychik, MD
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THANK YOU!