Congenital Cardiac Anesthesia as a Specialty: Where We’ve Been & Where We’re Going

A Septuagenarian Perspective

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Congenital Cardiac Anesthesia Society
10th Annual Meeting
Speaker’s 45 Year Perspective

- Surgical and Cardiac Surgical Training: 1970-74, Columbia-New York Med Center & National Heart & Lung Institute, NIH

- Anesthesia and Cardiac Anesthesia training: late 1970ies Massachusetts General Hospital & Boston Children’s Hospital

- Pediatric Cardiac Anesthesia: 1980-2015, Boston Children’s
General Themes of Lecture

• Birth & Growth of Congenital Cardiac Anesthesia:  
  Knowledge Expansion from Many Anesthesiologists/Centers

• Evolution and Spread of Congenital Cardiac Anesthesia:  
  Surgical Challenges Require Innovative Anesthesia Solutions

• Anesthesia on the Cutting Edge of Surgery & Cardiology:  
  Difficult People, Anesthesia Professionals & Innovation’s Moral Dilemmas

• Subspecialty Maturation & its Obligations:  
  Preparing for the Future
1938-1968: 1st 30 Years

1938-1954

1946 First paper in cardiac anesthesia by Drs Harmel and Lamont

1938 First PDA done under mask anesthesia and cyclopropane

1954-1970


1955 Halothane used as inhalational anesthetic

1948 Premedication and importance of sedation

1955-1960 Although no anesthetic agent used during bypass, no mention of recall or awareness

1944 Intubation Drs Lamont and Harmel for BT shunt.

1952 Importance of understanding the pathophysiology of cardiac lesions and its effect on anesthetic management

1955-1960 Muscle relaxant succinylcholine used.

1948 Temperature control especially hypothermia

1957 ETCO2 is a reflection of pulmonary blood flow

1967 PDA transcatheter closure

1967 First cardiac transplant performed by Kantrowitz-no anesthetic description

1952 “Infants are oblivious to pain”
Anesthetist Betty Lank & 1st Congenital Cardiac Anesthetic:
1938 Open Thoracotomy PDA Ligation with Mask Cyclopropane
Lorraine Sweeney: 1st Postop day
Lorraine Sweeny at 80 in 2011:
73 years & 5 grandchildren after PDA closure @ 7 yrs
1968-1988: Next 20 Years

1968
- First description of DHCA without intubation

1970
- Edward Lowenstein described the use of morphine 1mg/kg and 100% Oxygen for adult cardiac cases

1970-1980
- New inhalational anesthetic, Isoflurane
- Use of non depolarizing muscle relaxant
- pH stat improves pulmonary blood flow
- Use of PGE1 for PDA

1970s
- "Team concept" developed with cardiologists, cardiac surgeons, and anesthesiologists

1970-1980
- Use of synthetic opiates for cardiac surgery became available and spread to pediatric cardiac anesthesia

1980
- Recognizing the neuro-physiological response to DHCA

1980-1990
- Blood gas management using pH stat and Alpha stat
- Norwood describes successful palliation of hypoplastic left heart syndrome
- First description by Gregory for use of high dose fentanyl and pancuronium for PDA closure

1983
- Understanding the existence of a relationship between PaCO2, pH and PVR

1986
- Single ventricle and importance of balancing PVR and SVR-effect of PaO2 and PaCO2

1987
- Recognition of stress response in infants and neonates
Dolly D. Hansen, MD: Chief of Cardiac Anesthesia
Boston Children’s Hospital 1980-2002
Inflow Occlusion (1982) to avoid CPB in Infants
Infant Anesthetized Prior to Ice Bath for DHCA
Cooling in Ice Bath Prior to Sternotomy & CPB
Access to Heart & Great Vessels Challenges Anesthetic Management: Surgeons & then Cardiologists

- PDA ligation, shunts & coarctations needed endotracheal tubes & PPV
- Intra-cardiac repairs led to:
  - Inflow occlusion +/- mild hypothermia.
  - Atrial well approach to ASD.
  - Early CPB for complex lesions had high infant/child mortality & morbidity in 1960-70ies.
  - Deep hypothermia and cardiac arrest w/o CPB and then for CBP warming in 1970-80ies.
  - Regional brain perfusion & other techniques to avoid neurologic damage.
  - Progressive refinement in CPB bypass techniques allowing 3+ hr CPB in 1+ kg neonate.
  - Prolonged ECMO, LVAD, artificial heart and membrane lung support now routine.

- Interventional Catheterization arises to address CPB morbidity
  - PDA Closures
  - Balloon Dilations of Stenotic vessels, valves, & PFOs
  - ASD, VSD closures
  - Percutaneous valve replacement
  - Shunt creation procedures
  - Ablation Procedures
Substantial Morbidity and Mortality as Innovative New Procedures and Treatments are Introduced:

• *Professional challenges to decrease mortality & morbidity.*

• *Associated ethical challenges until techniques improve & adverse events decrease.*
  – Difficult people & inter-professional conflict.
  – Disruptions among care team.
  – Who decides whether innovative care is justified?

• *Issue for all congenital cardiac centers.*
Innovation Leads to Controversy

• HLHS and Single Ventricle:  
  \textit{Fontan Procedure to Two-Ventricle Repairs}

• Transposition of the Great Arteries:  
  \textit{Mustard/Senning Atrial Switch to Arterial Switch}

• Interventional Cardiac Catheterization:  
  \textit{PDA closure to Valve Replacements}
1988-2015: Last 27 Years

1990’s Introduction and use of NO to control pulmonary hypertension

1991 First fetal cardiac intervention in utero for critical aortic stenosis—Anesthetic for the fetus with cardiac disease

1990’s Increased emphasis on the importance of team approach including surgeon, anesthesiologist, cardiologist, and intensivist

1995 Additional new anesthetic drugs applied in cardiac anesthesia: sevoflurane, desflurane, propofol

1997 Improved monitors of cerebral function: Near-infrared spectroscopy and transcranial Doppler U/S

2000 Emergence of Extracorporeal Membrane Oxygenation

2000’s Expansion of cardiac MRI in children with congenital heart disease

2005 Congenital Cardiac Anesthesia Society

2011 Approval of EXCOR® Device by FDA. Challenge of anesthetic management of patient with Mechanical support devices
Subspecialty Maturation & Its Obligations

– Training Congenital Cardiac Anesthesiologists for the Future.

– Subspecialty-wide Collection of Outcome Data: What’s our morbidity?

– Translational and Basic Research: Finding better ways.
2015+: Where Are We Going?

• More adult patients with congenital cardiac problems

• New & better drugs:
  – *Etomidate without adrenal suppression: carboetomidate.*
  – *Long acting local anesthetics >48 hr: Neosaxitoxin.*
  – *Anesthetics without neurotoxicity: dexmedetomidine & Xeon.*

• New & better techniques:
  – *Microbubble oxygenation for resuscitation & severe cyanosis.*
  – *US & IR visual guidance of robotic catheter intracardiac repairs.*
  – *Tissue engineered autologous heart valves & conduction tissue.*
  – *Staged procedures, GFs & stem cells for vessel & chamber growth.*
  – *Real time intraoperative CBF & ICP monitoring for procedures.*
2015+: Where Are We Going?

- Better outcome data collection: CCAS STS Database Committee
  - 50 out of 120 centers in US participating & paying dues.
  - 48 centers submitting some data
  - Bias towards large and very large centers.
  - Transparent analysis of outcome data crucial to maturation & standing of subspecialty of congenital cardiac anesthesia

- Formalization of congenital cardiac anesthesia training:
  - Congenital cardiac anesthesia fellowship training not ACGME accredited
  - Variation in training programs content, quality, length & structure
  - Accreditation process takes several years
Educational Milestones for Pediatric & Cardiac Anesthesia

1997: Pediatric Anesthesia Fellowship Accreditation
2006: Adult Cardiac Anesthesia Fellowship Accreditation
2012: Pediatric Anesthesia Board Certification
????: Pediatric Cardiac Anesthesia Fellowship Accreditation
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<td>Muscle relaxant methohexitone used.</td>
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<td>1958-1964</td>
<td>First paper on cardiac anesthesia by Drs Harmel and Latore</td>
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<td>1959-1960</td>
<td>Vagal signs monitoring included ECG, Orimeter, and arterial blood pressure.</td>
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<td>1960</td>
<td>First description of EHCA without intubation</td>
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<td>1963</td>
<td>Use of synthetic oxygen for cardiac surgery became available and spread to pediatric cardiac anesthesiology</td>
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<td>1965</td>
<td>Use of methohexitone during surgery in the US</td>
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<td>1984</td>
<td>Premedication and importance of sedation</td>
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<td>1985</td>
<td>Updated with the use of nitrous oxide</td>
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<td>1990</td>
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<td>1993</td>
<td>Use of nitrous oxide in children with congenital heart disease</td>
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<td>1997</td>
<td>Improved monitoring of cardiac function: Neonatal monitoring, and transcranial Doppler U.S.</td>
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<td>2000</td>
<td>New advances in the use of nitrous oxide</td>
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Lessons Learned in 45 Years

• Teams are better than the sum of their individuals:
  
  *Talk to the people in your team and hear what they say.*

• Cardiac Surgeons & Interventional Cardiologists are people too:
  
  *Especially outside the OR and Cath Lab.*

• Today’s dogmas will become yesterday’s mistakes:
  
  *Never be too sure of anything you think you know.*

• The privilege of meeting the challenges of these patients is 2\textsuperscript{nd} only to the privilege of learning from one’s colleagues.