SEOUL

ASPA 2023

19th ASPA conference & 31st KSPA annual meeting

Equity and Quality in Pediatric Anesthesia

16 (Fri) - 18 (Sun) June, 2023

SC Convention Center, Seoul, Korea

ASPA

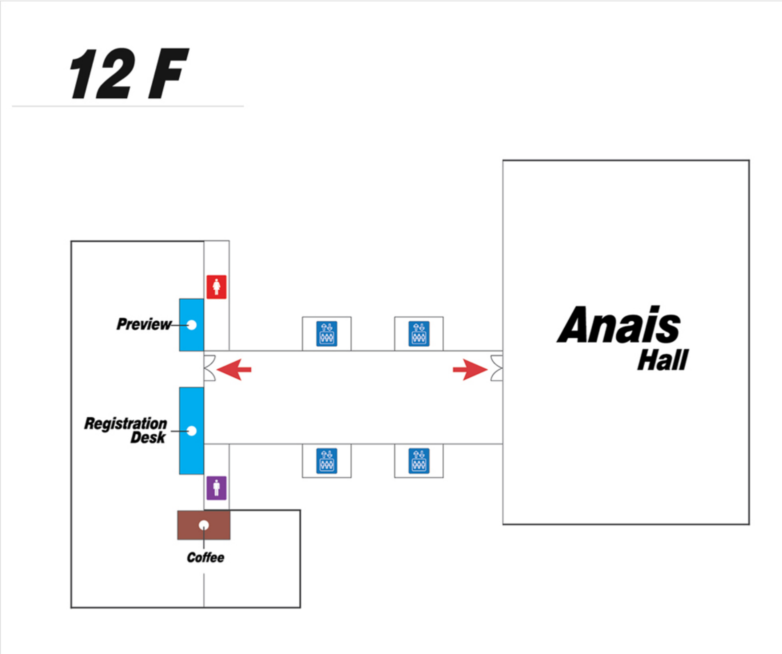
The Korean Society Pediatric Anesthesia

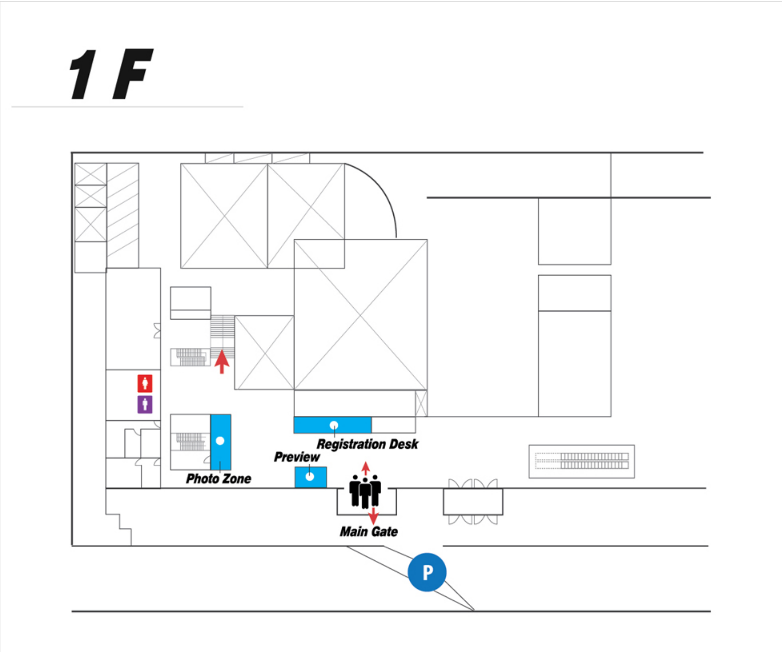
대한소아마취학회

INFORMATION

WIFI ID: KOFST-2
PW: 12345678

Floor Plan





WELCOME MESSAGE

The Korean Society of Pediatric Anesthesiologists (KSPA)

Dear Colleagues and Friends,

On behalf of the Organizing Committee, I am honored to host the 19th conference of the Asian Society of Paediatric Anaesthesiologists (ASPA 2023) in conjunction with the 31st Korean Society of Pediatric Anesthesiologists annual meeting in Seoul, South Korea on June 16-18, 2023.

Children are our future. Taking care of children's health is keeping "the value of the future." Pediatric anesthesiologists have a mission to ensure the safety and health of pediatric patients during the perioperative period. ASPA 2023 and its scientific program have been prepared with this in mind.

We have an exciting program at ASPA 2023 that will allow all of you to reflect upon and celebrate our past accomplishments, renew friendships and extend our networks, and jointly explore current and future research directions. We hope you will have a productive and fun?filled time at this special conference. The backdrop of the beautiful and historic city of Seoul will add to the pleasure of the meeting and provide lasting memories beyond medicine. You can expect a fascinating, fruitful, and enjoyable time in Seoul.

Looking forward to welcoming you to Seoul, South Korea for ASPA 2023!

President of Korean Society of Pediatric Anesthesiologists

Jin-Tae Kim

WELCOME MESSAGE

The Asian Society of Paediatric Anaesthesiologists (ASPA)

Dear friends and colleagues

We have now entered a new year, a fresh beginning. With the pandemic mostly under control, I am thankful that we can meet face to face, in Seoul for the 19th ASPA meeting.

People say that "Children's health is our nation's wealth" and health in the early years is important to allow children to thrive and grow into healthy adults.

ASPA is dedicated to fostering safe and high standards of Paediatric Anaesthesia for children in Asia. We hope to achieve this through sharing and supporting each other through research, with development of newer drugs and improved technology enhancing our knowledge of how to monitor our patients in greater detail and depth.

The theme of ASPA 2023 is "Equity and Quality in Paediatric Anaesthesia". We recognize that children are not small adults and Paediatric Anaesthesiologists need to be sharper and have heightened senses when caring for a young child.

I trust that we will be learning plenty from the wonderful programme drawn up by Professor Jin Tae Kim and his team in the organizing committee for ASPA 2023.

I would like to thank everyone for their contributions in making ASPA 2023 a success.

President of Asian Society of Paediatric Anaesthesiologists

Josephine Tan

COMMITTEES

Committee of KSPA 2023

President	Jin-Tae Kim	Seoul National University
Director of Planning	Byung Gun Lim	Korea University
Director of Academic Affairs	Jeong-Rim Lee	Yonsei University
Director of Publications	Hee Young Kim	Pusan National University
Director of Training	Eugene Kim	Hanyang University
Director of Education	Hyo-Jin Byon	Yonsei University
Director of Medical Insurance	Yong-Hee Park	Chung-ang University
Director of Medical Information	Sooyoung Cho	Ewha Womans University
Director of Treasurer	Seokyoung Song	Daegu Catholic University
Director of Cooperation	In-Kyung Song	University of Ulsan College of Medicine
Director of Research and Development	Won-Jung Shin	University of Ulsan College of Medicine
Director of Public Relation	Woo Suk Chung	Chungnam National University
Executive Secretary	Ji-Hyun Lee	Seoul National University
Steering Members	Hyun-Jung Kim	Jeju National University
	Helen Ki Shinn	Inha University
	Sang Hun Kim	Chosun University
	Jeonghan Lee	Inje University
	Younghee Shin	Samsung Medical Center
Auditor	Hyun Kang	Chung-ang University
Advisor	Il-Ok Lee	Korea University
	Hee-Soo Kim	Seoul National University
	Tae-Hun Ahn	Chosun University
	Sungsik Park	Kyungpook National University
	Ah Young Oh	Seoul National University

Committee of ASPA 2023

President	Josephine Tan	Singapore
President-Elect	Serpil Ustalar Ozgen	Türkiye
Honorary Secretary	Teddy Fabila	Philippines
Honorary Treasurer	Tracy Tan	Singapore
Committee Member	Vibhavari Naik	India
	Soichiro Obara	Japan
	Fauzia Khan	Pakistan
	Yunita Widyastuti	Indonesia
	Usha Nair	Malaysia
	Lydia Quitoriano	Philippines
	Hee-Soo Kim	Republic of Korea
	Duenpen Horatanaruang	Thailand
	Sokha Tep	Cambodia
Internal Auditor	Elsa Verghese	India
	Niki Suneerat	Thailand

SC Convention International Conference Hall (B1F)

Room A

08:30-09:00	Registration	
09:00-09:20	Welcome and Introduction	
	Opening Remarks	Jin-Tae Kim, President of KSPA
	Congratulatory Message	Jun Heum Yon, President of KSA
		Josephine Tan, President of ASPA

09:20-10:40	**Session 1. Society for Pediatric Anesthesia in the World: Past, Present, and Future**	Agnes Ng (Singapore) Jin-Tae Kim (Korea)
09:20-09:35	Why Pediatric Anesthesia Society is Special and Needed	Jim Fehr (USA)
09:35-09:50	The Future of Pediatric Anesthesiology around the World; We are Stronger Together	Randall Flick (USA)
09:50-10:05	ASPA: Past, Present, and Future	Josephine Tan (Singapore)
10:05-10:20	ESPA: How to Collaborate Internationally and Intercontinentally	Jurgen de Graaff (Netherlands)
10:20-10:40	Q&A	

10:40-11:00	Coffee Break	

11:00-12:30	**Session 2. WFSA Panel Discussion: Universal Coverage of Safe Pediatric Anesthesia All Over Asia**	Erlinda Oracion (Philippines) Il-Ok Lee (Korea)
11:00-11:15	Current Status of Pediatric Anesthesia in Cambodia, their Challenges and Opportunities for Improvement	Sokha Tep (Cambodia)
11:15-11:30	Current Status of Pediatric Anesthesia in Bangladesh, their Challenges and Opportunities for Improvement	Debabrata Banik (Bangladesh)
11:30-11:45	Activities of the WFSA Pediatric Anesthesia Committee	Norifumi Kuratani (Japan)
11:45-12:00	Activities and Accomplishments of the WFSA-BARTC Pediatric Fellowship Program	Patcharee Sriswasdi (Thailand)
12:00-12:15	Activities to Improve Patient Safety in WFSA	Erlinda Oracion (Philippines)
12:15-12:30	Q&A	

DAY 2 17 June 2023 (Sat)

SC Convention International Conference Hall (B1F)

12:30-14:00	**Luncheon Symposium**	Dong Woo Han (Korea)
	EEG Guided Anesthesia in Young Children (Virtual)	Ian Yuan (USA)
14:00-15:40	**Session 3. Preparing for the Future**	Choon Looi Bong (Singapore) Jun Heum Yon (Korea) Seong-Hyop Kim (Korea)
14:00-14:20	Thoughts on Professional Development and Career Success	Randall Flick (USA)
14:20-14:40	How to Prepare for the Next Pandemic?	Nicola Disma (Italy)
14:40-15:00	Time to Obtain Epidemiologic Data on Pediatric Anesthesia in Asia Itself: Introduction of PEACH Study	Soichiro Obara (Japan)
15:00-15:20	Future of Anesthesia-Related Neurotoxicity Issue: Update of TREX Study	Dean B Andropoulos (USA)
15:20-15:40	Q&A	
15:40-16:00	Coffee Break	
16:00-17:20	**Session 4. Issues We Are Facing & Need to Overcome**	Vibhavari Naik (India) Hee-Soo Kim (Korea)
16:00-16:20	Environmental Impact of Anesthesia (Virtual)	Diane Gordon (USA)
16:20-16:40	Healing the Culture of Medicine	Rebecca Margolis (USA)
16:40-17:00	Challenges Faced in Providing Safe Anaesthesia to Children in Low and Middle-Income Countries	Rebecca Jacob (India)
17:00-17:20	Q&A	
17:20	Closing Remarks	
18:30	**Gala Dinner**	

DAY 2 17 June 2023 (Sat)

SC Convention International Conference Hall (B1F)

Room B		
09:00-09:20	Welcome and Introduction (Room A)	
09:20-10:40	**Session 1. Optimization of Intraoperative Ventilation in Children**	Ekta Rai (India) Chul-Ho Chang (Korea)
09:20-09:35	Optimal Target of O_2 and CO_2	Sung-Ae Cho (Korea)
09:35-09:50	PEEP and Recruitment, Mode of Ventilation	Pichaya Waitayawinyu (Thailand)
09:50-10:05	Smart Choice of Ventilation-Related Equipment	Joy Luat-Inciong (Philippines)
10:05-10:20	How to Optimize Our Children's Intraoperative Ventilation Care with POCUS	Ayse Çiğdem Tutuncu (Türkiye)
10:20-10:40	Q&A	
10:40-11:00	Coffee Break	
11:00-12:30	**Session 2. Experts' Advice of Monitoring for Better Anesthesia Care**	Joy Luat-Inciong (Philippines) Hyo-Jin Byon (Korea)
11:00-11:20	Blood Pressure Considerations in Pediatric Anesthesia	Stephen Gleich (USA)
11:20-11:40	The Use of Neuromonitoring in Neonatal Pain Assessment (Virtual)	Ian Yuan (USA)
11:40-12:00	Accurate and Reliable Neuromuscular Monitoring in Children	Serpil Ozgen (Türkiye)
12:00-12:20	How to Assess Fluid Responsiveness in Children	Eun-Hee Kim (Korea)
12:20-12:30	Q&A	
12:30-14:00	**Luncheon Symposium (Room A)**	Dong Woo Han (Korea)
	EEG Guided Anesthesia in Young Children (Virtual)	Ian Yuan (USA)

DAY 2 17 June 2023 (Sat)

SC Convention International Conference Hall (B1F)

14:00-15:40	**Session 3. Sharing the Knowledge of NORA**	Vivian Yuen (Hong Kong) Yong-Hee Park (Korea)
14:00-14:15	Remimazolam and Dexmedetomidine: Clinical Applications and Limitations	Keira Mason (USA)
14:15-14:30	Needle-Free Sedation	Jurgen de Graaff (Netherlands)
14:30-14:45	How to Deal with Challenging Sedation Cases	Eun-Young Joo (Korea)
14:45-15:00	NORA for Children with Special Needs	Ina Ismiarti Binti Shariffuddin (Malaysia)
15:00-15:15	Neonatal Sedation for MRI	Yu Cui (China)
15:15-15:40	Q&A	
15:40-16:00	Coffee Break	
16:00-17:20	**Session 4. Perioperative Concerns in Pediatric Anesthesia**	Tae-Hun Ahn (Korea) Woo Suk Chung (Korea)
16:00-16:20	Perioperative Hypothermia in Children: Risk Factor and Preventive Stretagy	Djayanti Sari (Indonesia)
16:20-16:40	Emergence Agitation and Long Term Behavioral Consequences	Agnes Ng (Singapore)
16:40-17:00	Anesthesia-Induced Neurotoxicity: Recent Updates and Preclinical Research Trends	Woo Suk Chung (Korea)
17:00-17:20	Q&A	
17:20	Closing Remarks (Room A)	

Day 2

17 June 2023

Room A

ASPA 2023

Session 1.

Society for Pediatric Anesthesia in the World: Past, Present, and Future

Chair(s): Agnes Ng (Singapore)

Jin-Tae Kim (Korea)

Why the Society for Pediatric Anesthesia is Special and Needed

Jim Fehr

Stanford's Lucile Packard Children's Hospital, USA

Disclosures

Nothing to Disclose

Society for Pediatric Anesthesia — education • research • patient safety

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Objectives *At the end of this lecture the learner will be able to:*

- Describe the development of the Society for Pediatric Anesthesia (SPA)
- Discuss how the Society for Pediatric Anesthesia is contributing to improving the perioperative care of children
- Access and use the PediCrisis app developed by the SPA

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Objectives

- Describe the development of the Society for Pediatric Anesthesia (SPA)
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Society for Pediatric Anesthesia — education • research • patient safety

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History of the SPA

- In the early 1980s there was no organization in the United States of America that represented everyone who practiced pediatric anesthesiology

Society for Pediatric Anesthesia — education • research • patient safety

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History of the SPA 2

- This prompted Dr. Myron Yaster in 1987 to create the Society for Pediatric Anesthesia (SPA)
- The original goal of the SPA was to hold an annual meeting
- The first SPA meeting was held in October 1987 in Atlanta, Georgia (USA) with 200 attendees

Dr. Myron Yaster
Founder of the SPA

Society for Pediatric Anesthesia — education • research • patient safety

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History of the SPA 3

- The SPA continues to grow and as of March 2023 currently represents over 4,000 pediatric anesthesiologists & trainees
- The SPA now holds 2 meetings annually
- The most recent meeting had over 1,275 attendees, 80% of them attending in person, the remainder attending virtually

Society for Pediatric Anesthesia — education • research • patient safety

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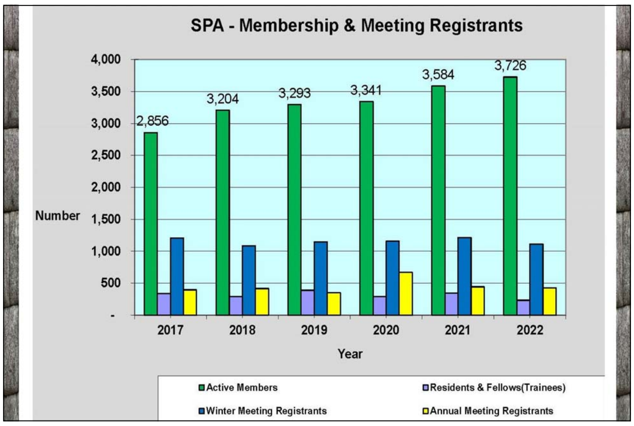

SPA Mission Statement

The Society for Pediatric Anesthesia advances the safety and quality of anesthesia care, perioperative care, and pain management in children by educating clinicians, supporting research, and fostering collaboration among clinicians, patient families, and professional organizations worldwide.

SPA Organizational Structure

- Executive Committee
  - President, Vice-President, Secretary-Treasurer, Past President
  - Each serves two year terms
  - This provides for an 8-year path of leadership continuity
  - Executive Committee members are elected by the SPA membership
- Board of Directors
  - Eight Directors elected by the SPA membership for 2-year terms

SPA Component Societies

Congenital Cardiac Anesthesia Society (CCAS) · Pediatric Anesthesia Leadership Council · Pediatric Anesthesiology Program Directors' Association (PAPDA) · Society for Pediatric Pain Medicine (SPPM)

SPA Committees

- Education Committee
- Quality & Safety Committee
- Research Committee
- SPA Global
- SPA Committee on Diversity, Equity and Inclusion (DEI)
- Well Being Committee

SPA Special Interest Groups

- Disaster Preparedness
- Mitochondrial Diseases
- Simulation
- Integrative Medicine
- PeDiR-Airway
- Pediatric Neuroanesthesia
- Trainee SIG
- Children with Special Needs SIG
- Liver & Intestinal Transplantation
- Biomedical Informatics
- Blood Management
- Fetal Anesthesia
- Pediatric Ambulatory Anesthesia
- Pediatric Craniofacial
- Pediatric Critical Care
- Sustainability
- Pediatric ERAS
- Ultrasound for Regional & POCUS

Dr. Myron Yaster, SPA Founder

Society for Pediatric Anesthesia
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- Trained at CHOP under Dr. Jack Downes
- Came to Hopkins under Dr. Mark Rogers
- 1987 Created the Society for Pediatric Anesthesia
- 2014 Received the SPA's Lifetime Achievement Award, subsequently known as the Yaster Award

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"Myron Yaster" Lifetime Achievement Award

- 2015: Bill Greeley, MD, MBA, CHOP
- 2016: Anne Lynn, MD, U Washington
- 2017: Aubrey Maze MD, Valley Anesthesia, Phoenix
- 2018: Chuck Berde, MD, PhD, Children's Boston
- 2019: George Gregory, MD, UCSF
- 2021: Eugenie S. Heitmiller, MD, FAAP, Hopkins/DC Children's
- 2022: Adrian T. Bosenberg, MB, ChB, FFA, U Washington

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Objectives

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SPA Component Societies

Society for Pediatric Anesthesia
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SPA Component Societies

Society for Pediatric Anesthesia
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- CCAS: Congenital Cardiac Anesthesia Society
- SPPM: Society for Pediatric Pain Medicine
- PALC: Pediatric Anesthesia Leadership Council
- PAPDA: Pediatric Anesthesiology Program Directors' Association

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SPA WELI

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- Founded by Dr. Jennifer Lee in June 2018, Women's Empowerment Leadership Initiative (WEI) supports the development of female leaders in pediatric anesthesiology
- The mission of WELI is to empower highly productive women pediatric anesthesiologists to achieve equity, promotion, and leadership.
- Mentor-mentee pairings, workshops, and coaching sessions are provided throughout the year

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SPA DEI Committee

Society for Pediatric Anesthesia
education • research • patient safety

- The SPA Committee on Diversity, Equity and Inclusion (DEI) was founded in Spring 2018 and advocates for members of the SPA who have traditionally been underrepresented
- The SPA DEI Committee also speaks for marginalized patients and families whose care may be below standard and seeks to assure that all patients get the best of care regardless of their background

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SPA Investment in Research

Society for Pediatric Anesthesia
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- SPA Research, Education & Safety Fund (RE&SF) was established in 2014
- The SPA RE&SF provides $100,000 annually for research grants to one or two young investigators
- The SPA RE&SF also supports SPA's global outreach

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SPA Global

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- Created to focus efforts to enhance pediatric perioperative care world wide
- SPA Global has supported a fellow in Kenya for the last 10 years
- SPA Global has added support for a pediatric anesthesiology fellow in Thailand

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SPA Global Outreach

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Supports international scholars attendance at the SPA meeting

– 2018 – **Walid Habre MD, PhD**; Geneva, Switzerland
– 2019 – **Britta Von Ungern-Sternberg, MD MB BCh PhD**; Perth, Australia
– 2020 – **Clover-Ann Lee, MD**; Johannesburg, South Africa
– 2021 – **Jeong-Rim Lee, MD, PhD**; Seoul, South Korea
– 2022 – **Rodrigo Lopez Barreda MD**; Santiago, Chile
– 2023 – **Zipporah Gathuya, MBCHB, MMED** Nairobi, Kenya

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Objectives

Society for Pediatric Anesthesia
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SPA Critical Events Checklists

- In 2007 the SPA Quality & Safety Committee created the Critical Event Checklists which are evidence-based and supported by expert consensus
- Current languages: Spanish, Chinese, French, Portuguese, Tagalog, Turkish, Ukrainian, Hebrew

https://pedsanesthesia.org/critical-events-checklists/

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SPA Critical Events Checklists

- The 26 checklists are continually updated based on the most recently available evidence/guidelines
- Focused on what a pediatric anesthesiologist needs to know to manage an emergency in the perioperative period

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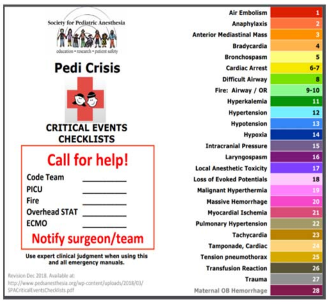
SPA Critical Events Checklists



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Cardiac Arrest

Pulseless cardiac arrest — 6

- Notify team, call for help and code cart/defibrillator
- Increase oxygen to 100%. Turn off anesthetics
- If ETT, 100-120 chest compressions/min + 10 breaths/min. Avoid hyperventilation.
- If no ETT, 15:2 compression:ventilation ratio (100-120 chest compressions/min + 8 breaths/min)
- For chest compressions, maximize $EtCO_2$ > 10 mmHg (see next card for more details):
  - Switch compressor every 2 min
  - Use sudden increase in $EtCO_2$ for ROSC, Do NOT stop compressions for pulse check
- Obtain defibrillator. **Attach pads**. If VF/VT, shock 2 joules/kg. Continue chest compressions x 2 minutes.
- Start timer. Designate team leader. Assign roles. Designate a scribe/recorder. Notify family. Continue with next items in yellow box

Repeat sequence below until return of spontaneous circulation:
- If still in VF/VT, shock 4 joules/kg q2 min (up to 10 joules/kg on subsequent shocks)
- Resume chest compressions immediately regardless of rhythm
- EPINEPHrine 10 MICROgrams/kg IV q 3-5 min while in arrest (MAX 1 mg)
  - If still no ROSC after second dose of EPINEPHrine, **activate ECMO** (if available)
- Check pulse & rhythm q 2 min during compressor change
- Check for reversible causes (Hs and Ts) early and often (see table below)
- Lidocaine 1 mg/kg bolus (MAX 100 mg); may repeat (total: 2 doses) **OR** amiodarone 5 mg/kg bolus; may repeat (total: 3 doses)
- Repeat sequence in this box until return of spontaneous circulation

Hs and Ts: Reversible Causes	
• Hypovolemia	• Tension Pneumothorax
• Hypoxemia	• Tamponade (Cardiac)
• Hydrogen ion (acidosis)	• Thrombosis
• Hyperkalemia/Hypoglycemia	• Toxin (anesthetic, β-blocker)
• Hypothermia	• Trauma (surgical or nonsurgical bleeding)

Cardiac Arrest
Revision Oct 2018

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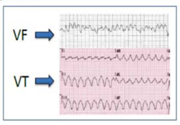
Cardiac Arrest: VF/VT

Shockable, pulseless cardiac arrest — 7

- Start chest compressions (100 chest compressions/min + 8 breaths/min)
  - Place pt on backboard, maintain good hand position; if prone, see 'Prone CPR' card
  - Maximize $EtCO_2$ > 10 mmHg with force/depth of compressions
  - Allow full recoil between compressions
  - Switch compressor every 2 min
  - Use sudden increase in $EtCO_2$ for ROSC
  - Do NOT stop compressions for pulse check



- Give 100% oxygen. Turn off anesthetics
- Start timer. Designate team leader. Assign roles
- Obtain defibrillator. Attach pads. Shock 2-4 joules/kg
- Resume chest compressions immediately
- Epinephrine 10 MICROgrams/kg IV q 3-5 min while in arrest
- Check pulse & rhythm q 2 min during compressor change
- Check for reversible causes (Hs and Ts) early and often (see previous 'Cardiac Arrest' card)
- If VF/VT continue:
  - Shock 4 joules/kg
  - Resume chest compressions for 2 min regardless of rhythm
  - Check pulse & rhythm q 2 min during compressor switch
  - Repeat epinephrine 10 MICROgrams/kg IV q 3-5 min if VF/VT continue
  - If VF/VT continue 2 min after previous defib attempt, shock 4-10 joules/kg and resume chest compressions for 2 min; check pulse with compressor change; repeat sequence until ROSC
- Lidocaine 1 mg/kg bolus OR amiodarone 5 mg/kg bolus; may repeat (total of 2 doses)
- If cardiac arrest > 6 min, activate ECMO (if available)

Cardiac Arrest: VF/VT

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PediCrisis App 2.0

- The SPA Critical Events checklists were adapted as a free smartphone app in 2013
- PediCrisis 1.0 featured 18 scenarios

- PediCrisis 2.0, the most recent version, features all 26 scenarios

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PediCrisis App 2.0

- Smartphone versions are available in English & Spanish
- PediCrisis has been downloaded over 25,000 times from 132 countries

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PediCrisis App 2.0

- Download for free from Apple iOS and Android Store
- No internet connection needed after initial download

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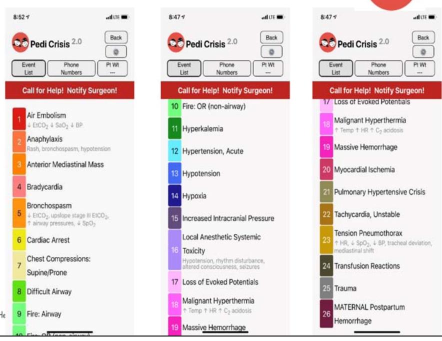
PediCrisis App 2.0



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PediCrisis App 2.0

Navigate directly to:

- ❑ Event List
- ❑ Phone number
- ❑ Weight entry

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Objectives *At the end of this lecture the learner will be able to:*

✓ Describe the development of the Society for Pediatric Anesthesia (SPA)

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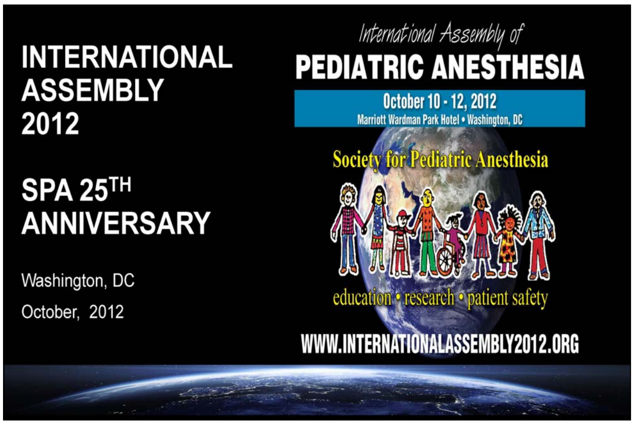
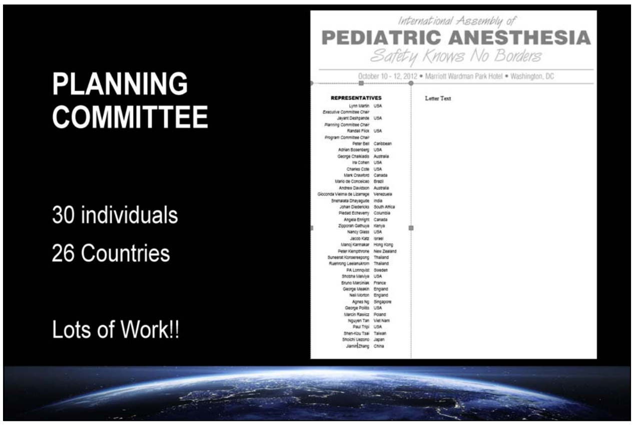
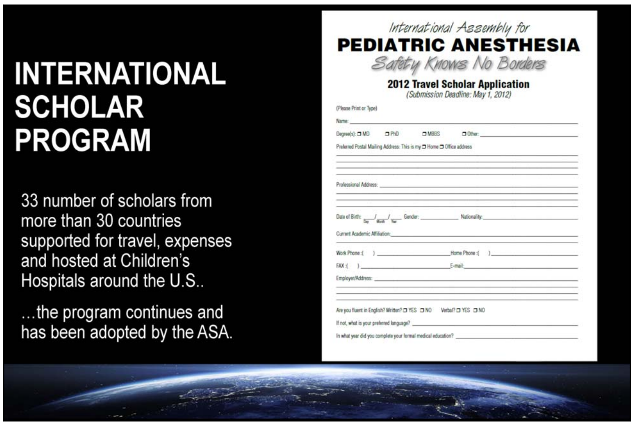
The Future of Pediatric Anesthesiology around the World; We are Better Together

Randall Flick

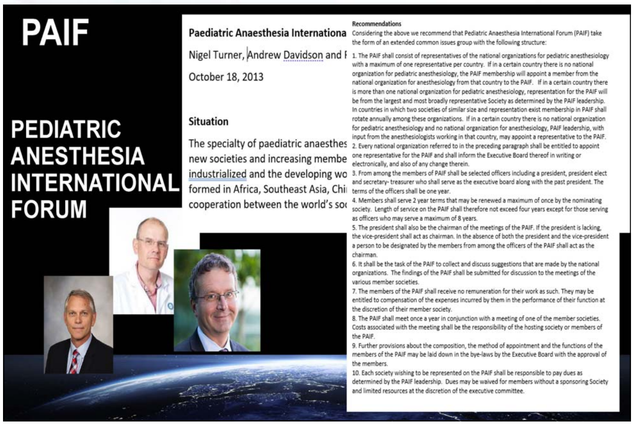
Mayo Clinic Children's Center, USA







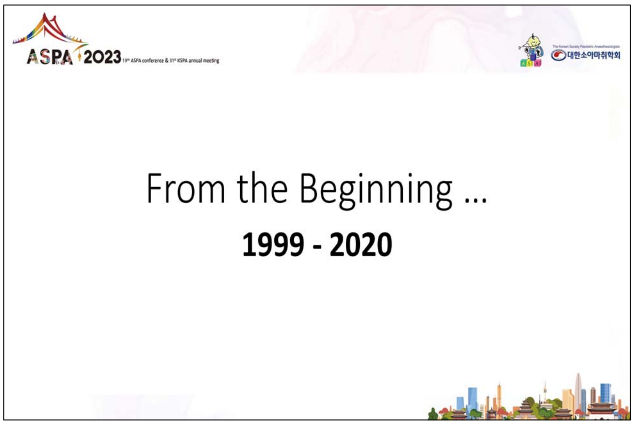
Randall Flick: The Future of Pediatric Anesthesiology around the World; We are Better Together

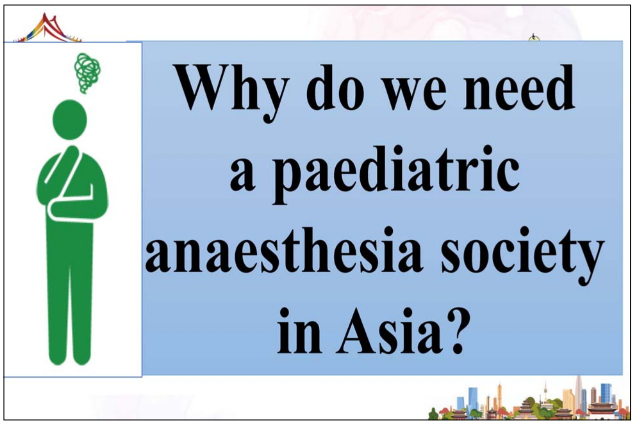


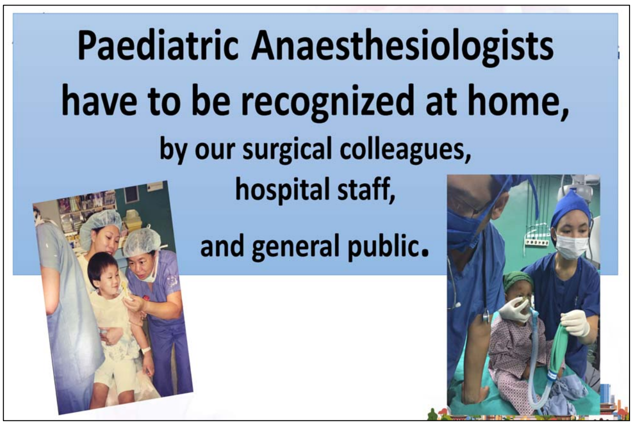
Asian Society of Paediatric Anaesthesiologists: Past, Present, and Future

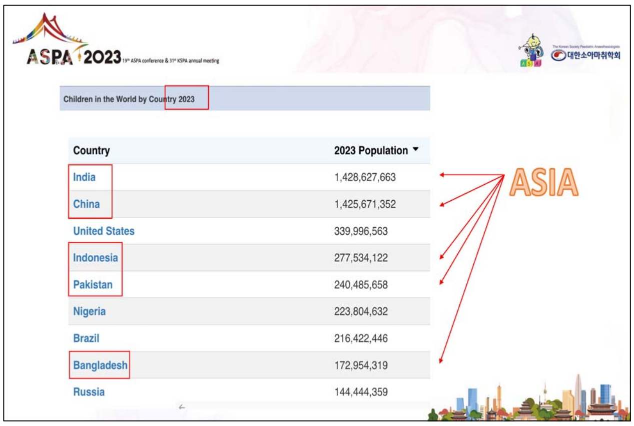
Josephine Tan

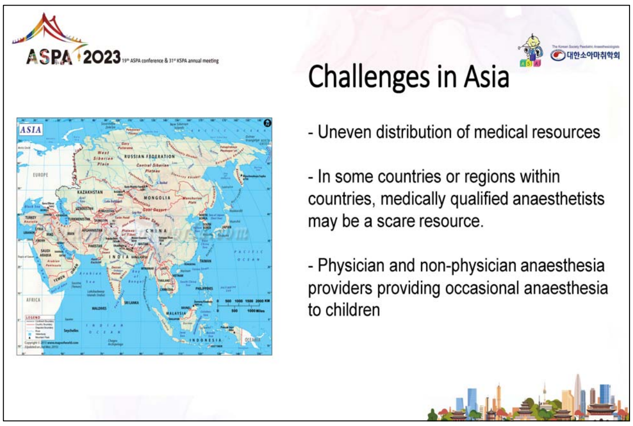
KK Women's and Children's Hospital, Singapore

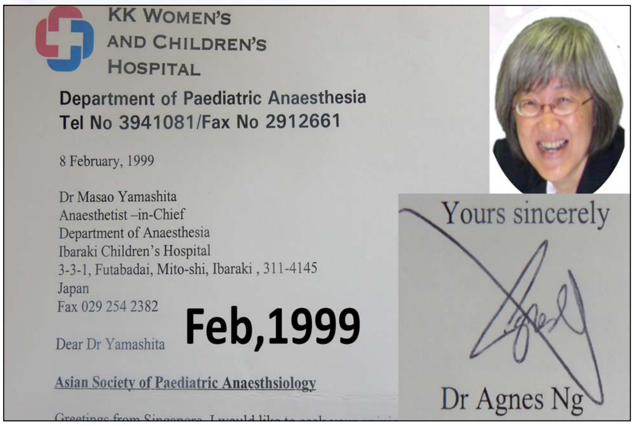


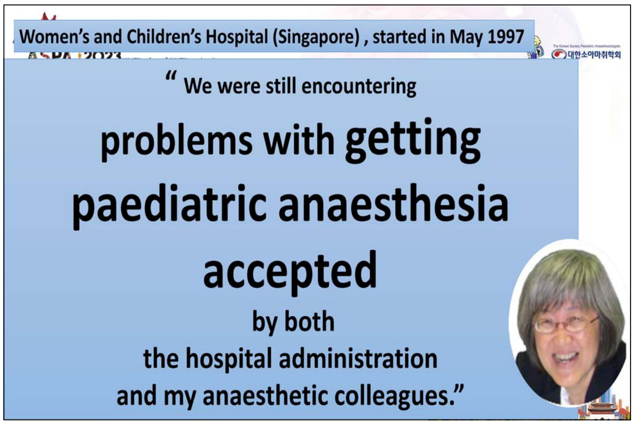


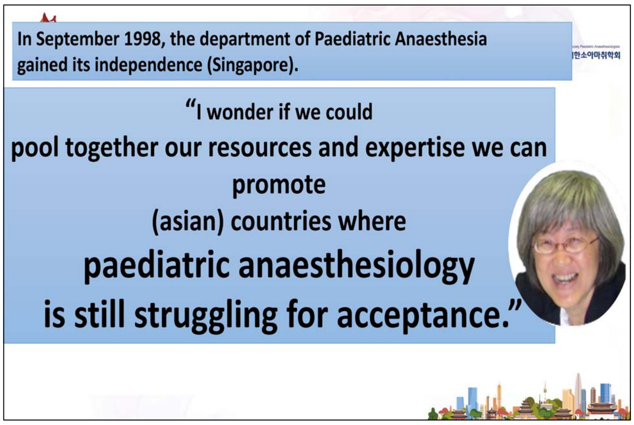




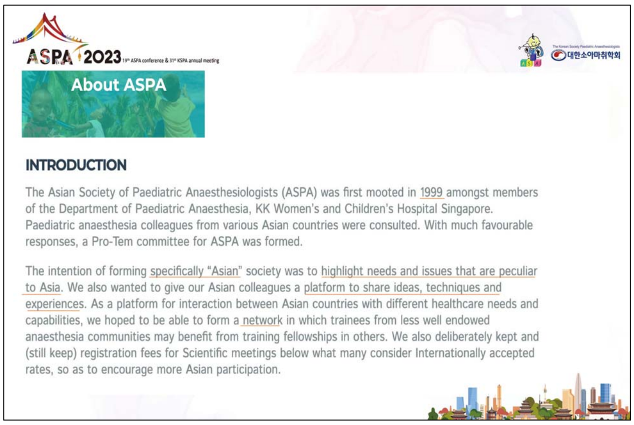


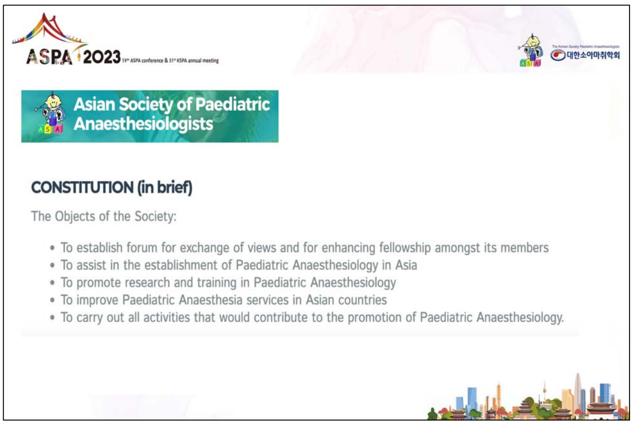

KK Women's and Children's Hospital
Department of Paediatric Anaesthesia
Tel No 3941081/Fax No 2912661
8 February, 1999
Dr Masao Yamashita
Anaesthetist –in-Chief
Department of Anaesthesia
Ibaraki Children's Hospital
3-3-1, Futabadai, Mito-shi, Ibaraki , 311-4145
Japan
Fax 029 254 2382
Dear Dr Yamashita
Feb,1999
Asian Society of Paediatric Anaesthsiology
Yours sincerely
Dr Agnes Ng

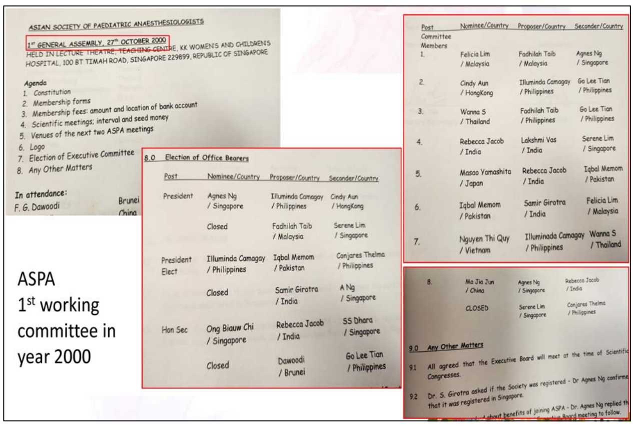

Women's and Children's Hospital (Singapore) , started in May 1997
" We were still encountering
problems with getting
paediatric anaesthesia
accepted
by both
the hospital administration
and my anaesthetic colleagues."


In September 1998, the department of Paediatric Anaesthesia gained its independence (Singapore).
"I wonder if we could
pool together our resources and expertise we can
promote
(asian) countries where
paediatric anaesthesiology
is still struggling for acceptance."

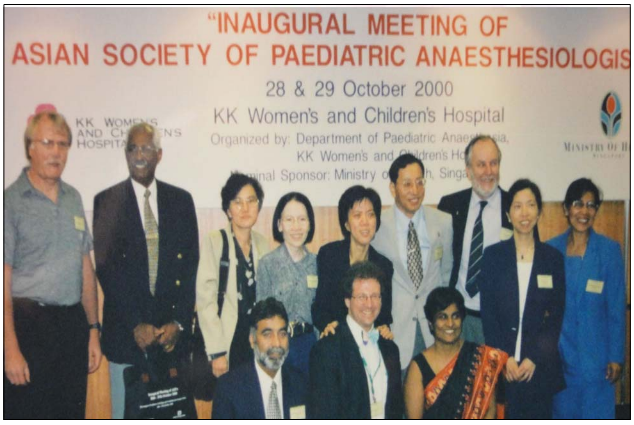

ASPA 2023
ASPA Vision Statement
Asian Society of Paediatric Anaesthesiologists
About
Contact
Membership
Past Meetings
ASPA e-Education (ASPA FLEX)
ASPA PPSIG
PPLS Manual
ASPA
Dedicated to fostering the highest standard of Paediatric Anaesthesia care in Asia.

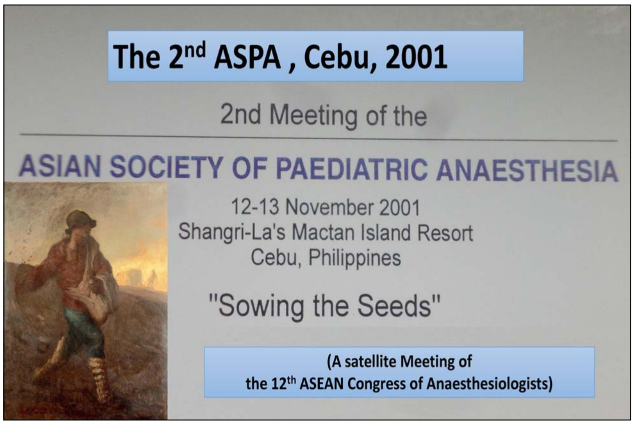

ASPA 2023
About ASPA
INTRODUCTION
The Asian Society of Paediatric Anaesthesiologists (ASPA) was first mooted in 1999 amongst members of the Department of Paediatric Anaesthesia, KK Women's and Children's Hospital Singapore. Paediatric anaesthesia colleagues from various Asian countries were consulted. With much favourable responses, a Pro-Tem committee for ASPA was formed.
The intention of forming specifically "Asian" society was to highlight needs and issues that are peculiar to Asia. We also wanted to give our Asian colleagues a platform to share ideas, techniques and experiences. As a platform for interaction between Asian countries with different healthcare needs and capabilities, we hoped to be able to form a network in which trainees from less well endowed anaesthesia communities may benefit from training fellowships in others. We also deliberately kept and (still keep) registration fees for Scientific meetings below what many consider Internationally accepted rates, so as to encourage more Asian participation.

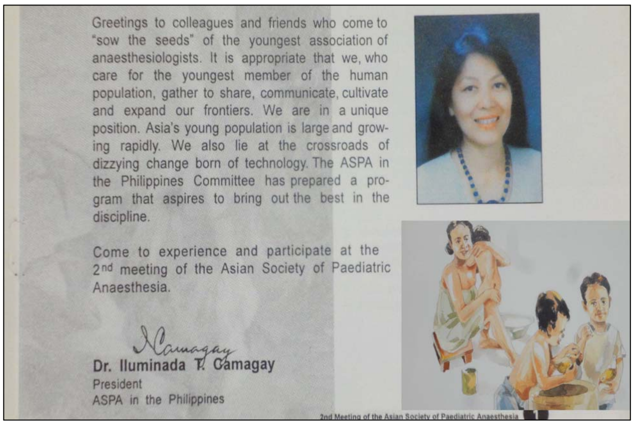

ASPA 2023
Asian Society of Paediatric Anaesthesiologists
CONSTITUTION (in brief)
The Objects of the Society:
• To establish forum for exchange of views and for enhancing fellowship amongst its members
• To assist in the establishment of Paediatric Anaesthesiology in Asia
• To promote research and training in Paediatric Anaesthesiology
• To improve Paediatric Anaesthesia services in Asian countries
• To carry out all activities that would contribute to the promotion of Paediatric Anaesthesiology.


ASIAN SOCIETY OF PAEDIATRIC ANAESTHESIOLOGISTS
1st GENERAL ASSEMBLY, 27th OCTOBER 2000
Agenda
1. Constitution
2. Membership forms
3. Membership fees: amount and location of bank account
4. Scientific meetings: interval and seed money
5. Venues of the next two ASPA meetings
6. Logo
7. Election of Executive Committee
8. Any Other Matters
8.0 Election of Office Bearers
ASPA
1st working
committee in
year 2000


INAUGURAL MEETING OF
ASIAN SOCIETY OF PAEDIATRIC ANAESTHESIOLOGISTS
28 & 29 October 2000
KK Women's and Children's Hospital
ORGANISING COMMITTEE
Chairman: Dr Tan Geok Mui
Honorary Secretary: Dr Agnes Ng
Scientific Convenors: Dr Rachael Pereira
Dr Tan Geok Mui
Dr Lim Suan Ling
Dr Pua Hwee Leng
Dr Shani Tan
Trade: Dr Shani Tan
Facilities: Dr Choo Shu May
Social: Dr Serene Lim
Dr Josephine Tan
Dr Michelle Tay
The 1st ASPA,
Singapore,2000

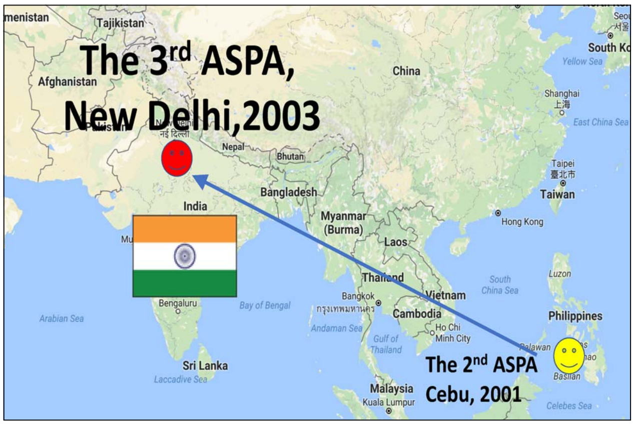


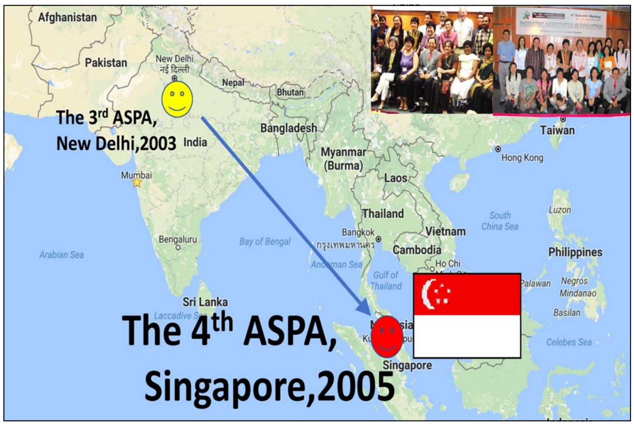


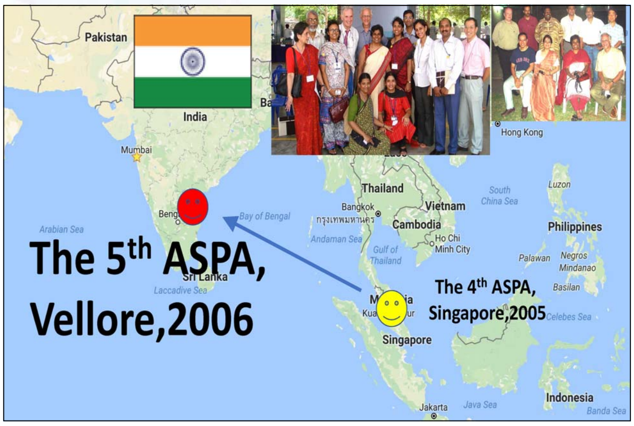

Greetings to colleagues and friends who come to "sow the seeds" of the youngest association of anaesthesiologists. It is appropriate that we, who care for the youngest member of the human population, gather to share, communicate, cultivate and expand our frontiers. We are in a unique position. Asia's young population is large and growing rapidly. We also lie at the crossroads of dizzying change born of technology. The ASPA in the Philippines Committee has prepared a program that aspires to bring out the best in the discipline.

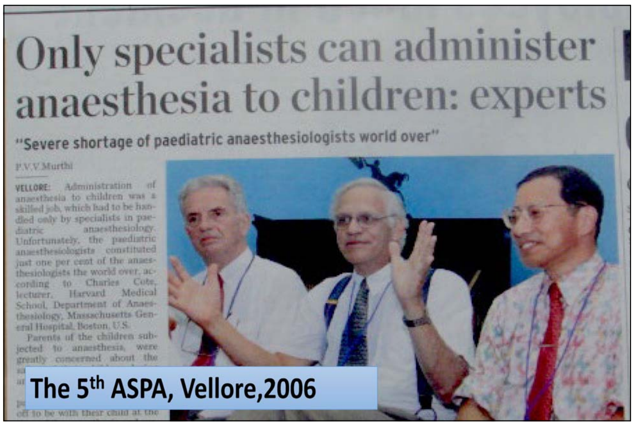
Come to experience and participate at the 2nd meeting of the Asian Society of Paediatric Anaesthesia.

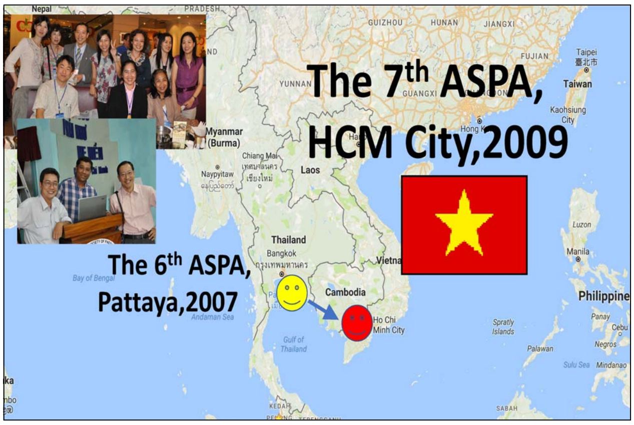
Dr. Iluminada T. Camagay
President
ASPA in the Philippines

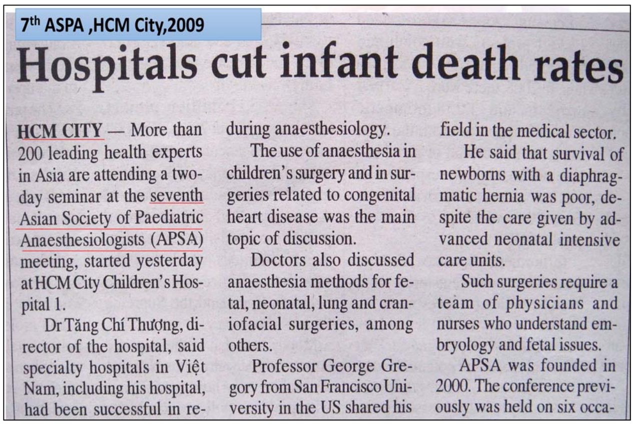












7th ASPA ,HCM City,2009

Hospitals cut infant death rates

HCM CITY — More than 200 leading health experts in Asia are attending a two-day seminar at the seventh Asian Society of Paediatric Anaesthesiologists (APSA) meeting, started yesterday at HCM City Children's Hospital 1.

Dr Tăng Chí Thượng, director of the hospital, said specialty hospitals in Việt Nam, including his hospital, had been successful in reducing infant deaths during anaesthesiology.

The use of anaesthesia in children's surgery and in surgeries related to congenital heart disease was the main topic of discussion.

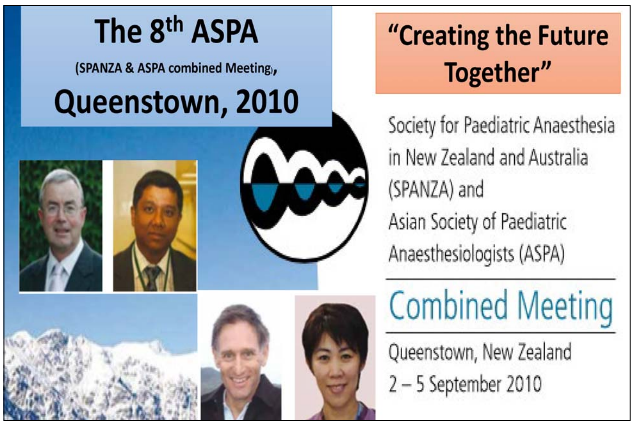
Doctors also discussed anaesthesia methods for fetal, neonatal, lung and craniofacial surgeries, among others.

Professor George Gregory from San Francisco University in the US shared his field in the medical sector.

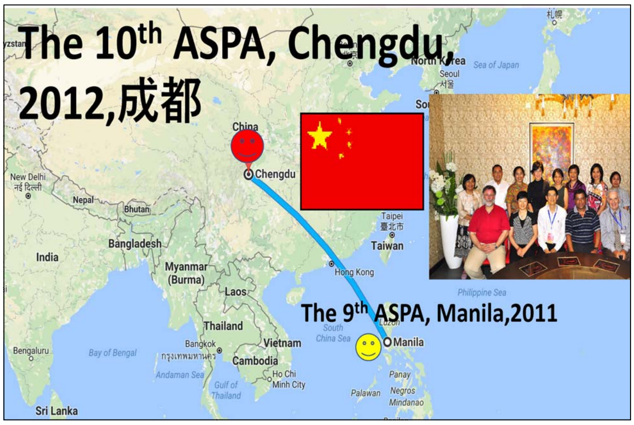
He said that survival of newborns with a diaphragmatic hernia was poor, despite the care given by advanced neonatal intensive care units.

Such surgeries require a team of physicians and nurses who understand embryology and fetal issues.

APSA was founded in 2000. The conference previously was held on six occa-




The 9th ASPA,
Manila, 2011
Manila
13 h 55 min
The 8th ASPA,
Queenstown, 2010
Queenstown


The 10th ASPA, Chengdu,
2012,成都
Chengdu
The 9th ASPA, Manila,2011
Manila

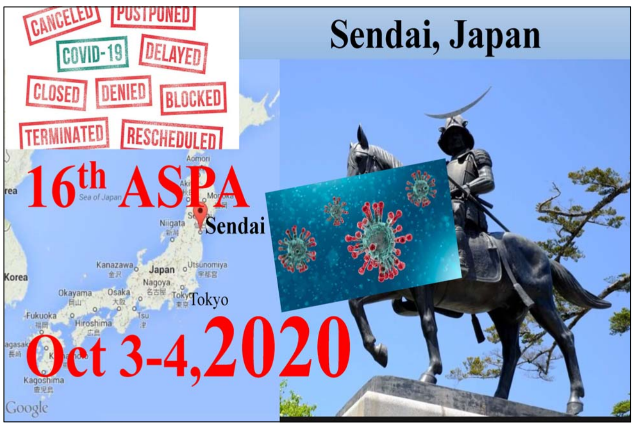

The 10th ASPA , Chengdu, 2012
成都
7 h 55 min
The 11th ASPA,
Jakarta, 2013
indoanesthesia 2013

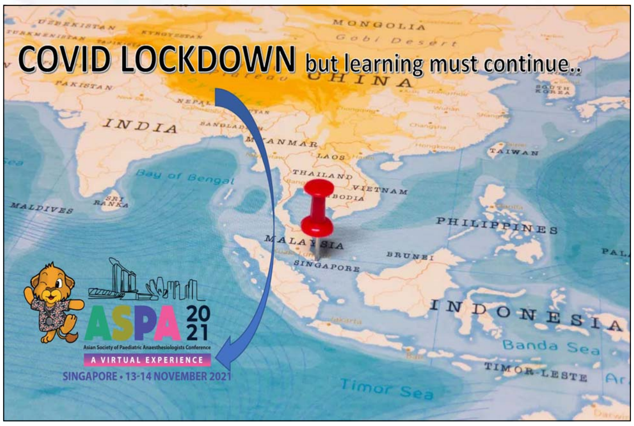

The 12th ASPA,
Istanbul, 2014
12 h 10 min
The 11th ASPA, Jakarta,2013
ISTANBUL
ASPA2014

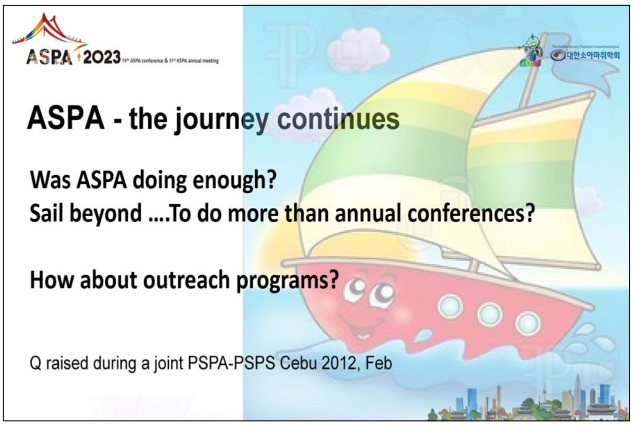

The 12th ASPA, Istanbul, 2014
13 h 15
The 13th ASPA,
Penang, 2015
George Town


The 14th ASPA,
Mumbai, 2017
7 h 35 min
The 13th ASPA, Penang, 2015


The 14th ASPA, Mumbai, 2017
4 h 15 min
The 15th ASPA,
Bangkok,2018


CANCELED
POSTPONED
COVID-19
DELAYED
CLOSED
DENIED
BLOCKED
TERMINATED
RESCHEDULED
Sendai, Japan
16th ASPA
Sendai
Tokyo
Oct 3-4,2020

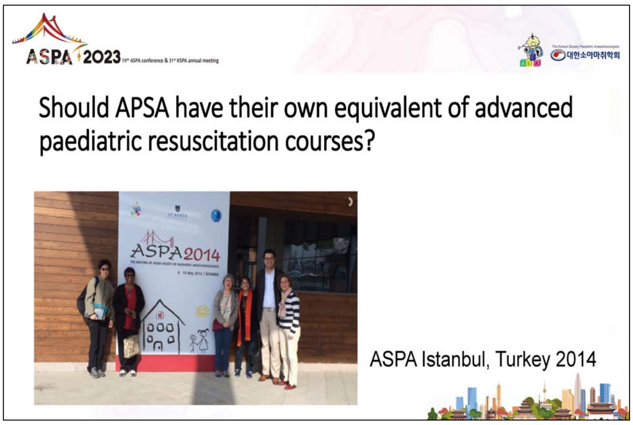

COVID LOCKDOWN but learning must continue..
ASPA 2021
A VIRTUAL EXPERIENCE
SINGAPORE • 13-14 NOVEMBER 2021


ASPA 2023
ASPA - the journey continues
Was ASPA doing enough?
Sail beyond ....To do more than annual conferences?
How about outreach programs?
Q raised during a joint PSPA-PSPS Cebu 2012, Feb

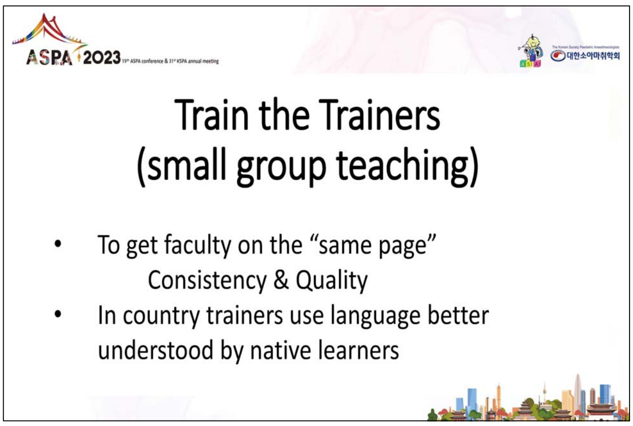

ASPA 2023
ASPA – Brainstorming in Singapore Aug, 2012
ASPA is small in size…
But BIG in commitment


ASPA 2023
"Safe PAN workshop"
FOCUS on Basic & Safe Paediatric Anaesthesia Practice
Maldives 2014
Mauritius 2015


ASPA 2023
"Safe PAN workshops"
Siem Reap, Cambodia 2015
Luang Prabang, Laos 2016
LAO FRIENDS


ASPA 2023
Should APSA have their own equivalent of advanced paediatric resuscitation courses?
ASPA 2014
ASPA Istanbul, Turkey 2014


ASPA 2023
NEW ASPA workshop…
"Paediatric Perioperative Life Support" (PPLS)
2014 Singapore
2015 Penang, Malaysia (fine-tune)


ASPA 2023
Train the Trainers
(small group teaching)
To get faculty on the "same page"
Consistency & Quality
In country trainers use language better understood by native learners


ASPA 2023
"Train the Trainers/TTT sessions"


ASPA 2023
Malaysian Society of Paediatric Anaesthesiologist PPLS – TTT course Jan 2018


ASPA 2023
Philippine Society of Pediatric Anesthesia
PPLS and TTT, Feb 2018


ASPA 2023
ASPA Collaborations
International, National and Local societies & Healthcare organisations
IAPA
WFSA
SmileTrain

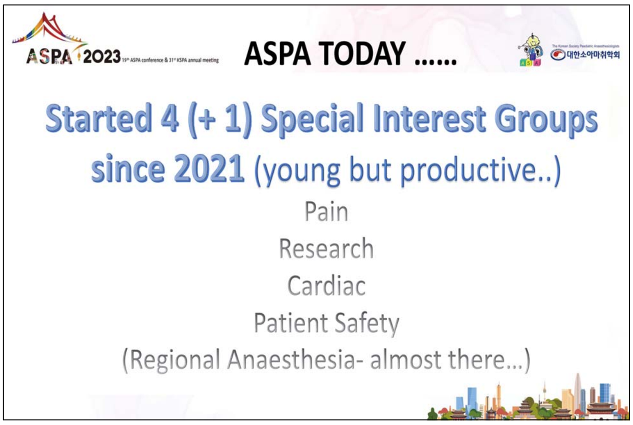

ASPA 2023
ASPA NOW….
TODAY in 2023


© WorldAtlas.com
North Korea
Seoul
South Korea
Japan
Ferry Sinking 4/16/2014
SOUTH KOREA
ASPA 2023
Equity and Quality in Paediatric Anaesthesia
19th Conference of the Asian Society of Paediatric Anaesthesiologists
31st Annual Meeting of the Korean Society of Paediatric Anaesthesiologists
16 (Fri) - 18 (Sun) June, 2023
SC Convention Center, Seoul, Korea

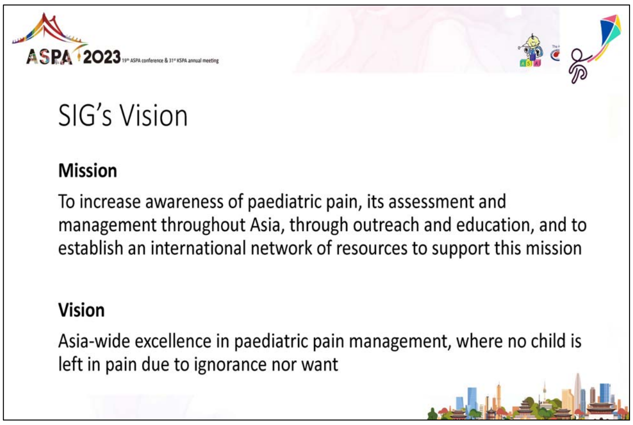

ASPA 2023
MEMBERSHIP
• 596
Singapore
Philippines
China
Parkistan
Thailand
cambodia
India
Hong Kong
Indonesia
Malaysia
Korea
Vietnam
Canada
Bhutan
Japan
Turkey
Maldives
Kenya
Bangladesh
USA
Uzbeckistan
Myanmar
Sri Lanka
Mongolia
Kosovo
Nepal
UAE
Mauritius

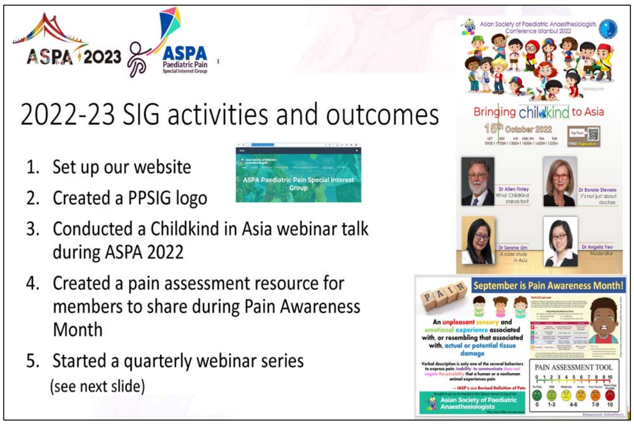

ASPA 2023
ASPA e-Education
Our Pursuit: To disseminate education for a holistic paediatric anaesthesia care.
ASPA Education Committee
Now into 3rd season of webinars……all available at ASPA website aspa-2000.com
Second ASPA-FLEX Webinar
First ASPA FLEX Webinar session capture
ASPA-FLEX Webinar Series Launch


ASPA 2023
Despite Covid restrictions... Still continuing with existing programmes --> PPLS
e-PPLS Philippines

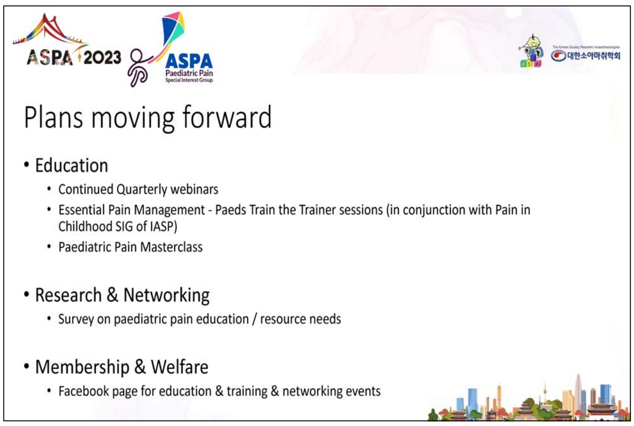

ASPA 2023
ASPA TODAY ......
Started 4 (+ 1) Special Interest Groups since 2021 (young but productive..)
Pain
Research
Cardiac
Patient Safety
(Regional Anaesthesia- almost there...)

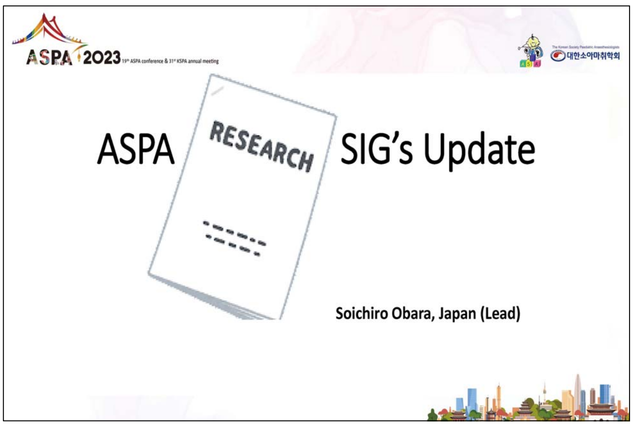

ASPA 2023
ASPA Paediatric Pain Special Interest Group
Honorary Advisor : Prof Allen Finley
President : Angela Yeo
President-Elect : Kathrina Epino
Secretary : Teddy Fabila
Treasurer : Jang Young-Eun
Education : Andi Ade Ramlan
Research : Ritu Pradhan
Membership : Janice Ng
Special Projects : Elvan Ocmen


ASPA 2023
SIG's Vision
Mission
To increase awareness of paediatric pain, its assessment and management throughout Asia, through outreach and education, and to establish an international network of resources to support this mission
Vision
Asia-wide excellence in paediatric pain management, where no child is left in pain due to ignorance nor want

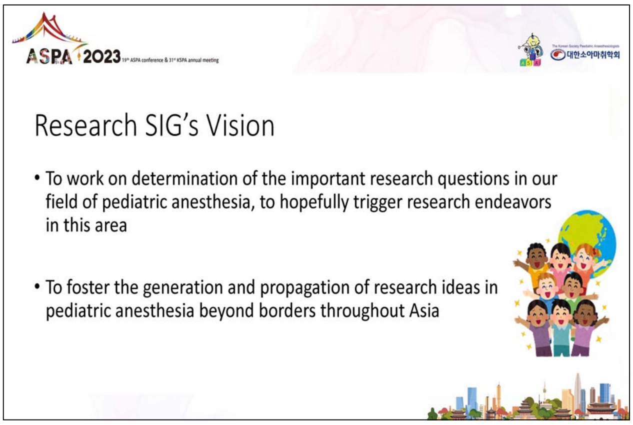

ASPA 2023
ASPA Paediatric Pain Special Interest Group
2022-23 SIG activities and outcomes
1. Set up our website
2. Created a PPSIG logo
3. Conducted a Childkind in Asia webinar talk during ASPA 2022
4. Created a pain assessment resource for members to share during Pain Awareness Month
5. Started a quarterly webinar series (see next slide)
Bringing childkind to Asia
September is Pain Awareness Month!
PAIN ASSESSMENT TOOL


ASPA 2023
ASPA Paediatric Pain Special Interest Group
2022-23 SIG activities and outcomes
Neurobiology of Pain
PEDIATRIC PERIOPERATIVE PAIN MANAGEMENT
Save the date!
8th July 2023 5pm SGT
Detecting neuropathic pain in children
Managing neuropathic pain in children
14 Oct 2023 5pm SGT
Oncological pain
Palliative pain
Interventional Procedures in Chronic Cancer Pain

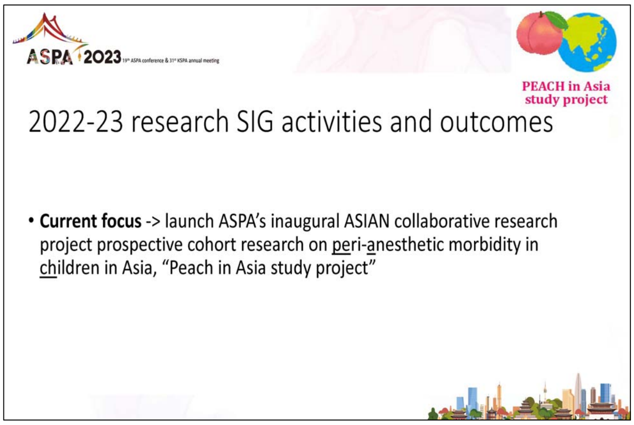

ASPA 2023
ASPA Paediatric Pain Special Interest Group
Plans moving forward
Education
Continued Quarterly webinars
Essential Pain Management - Paeds Train the Trainer sessions (in conjunction with Pain in Childhood SIG of IASP)
Paediatric Pain Masterclass
Research & Networking
Survey on paediatric pain education / resource needs
Membership & Welfare
Facebook page for education & training & networking events


ASPA 2023
ASPA
RESEARCH
SIG's Update
Soichiro Obara, Japan (Lead)

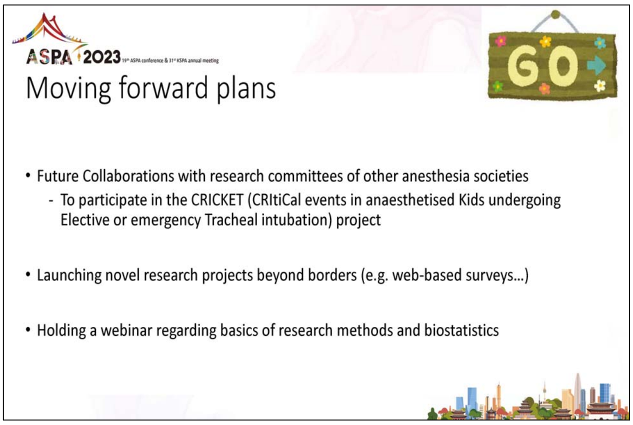
Asian PEdiatric Anesthesia Research (A-PEAR) team
(contributing to our research project)
Shemila Abbasi (Pakistan)
Josephine Tan (Singapore)
Choon Looi Bong (Singapore)
Soichiro Obara (Lead) (Japan)
Norifumi Kuratani (Japan)
Pheakdey Nhoung (Cambodia)
Evangeline Villa (Philippines)
Elsa Varghese (India)
Ekta Rai (India)
Z Serpil Ustalar Ozgen (Turkey)
Andi Ade W Ramlan (Indonesia)
Hyo-Jin Byon (South Korea)
Mahin Seyedhejazi (Iran)
Ina Ismiarti Shariffuddin (Malaysia)
Teresita A Batanes (Philippines)



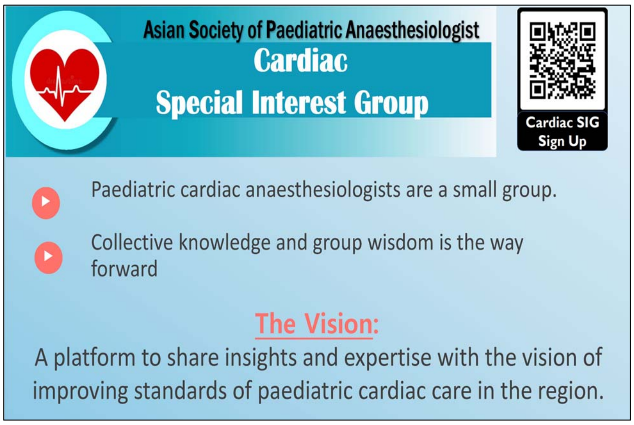
ASPA 2023
Research SIG's Vision
• To work on determination of the important research questions in our field of pediatric anesthesia, to hopefully trigger research endeavors in this area
• To foster the generation and propagation of research ideas in pediatric anesthesia beyond borders throughout Asia



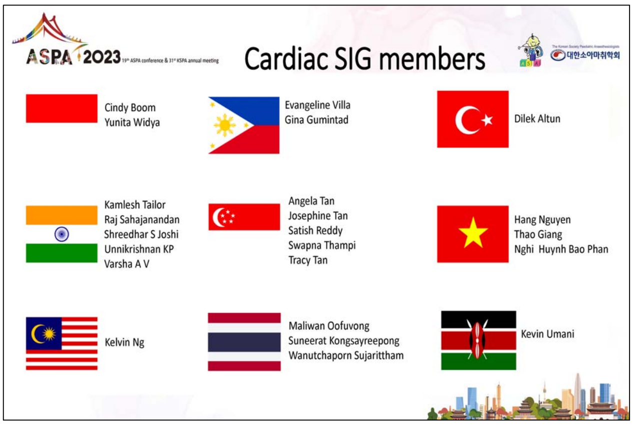
ASPA 2023
PEACH in Asia study project
2022-23 research SIG activities and outcomes
• Current focus -> launch ASPA's inaugural ASIAN collaborative research project prospective cohort research on peri-anesthetic morbidity in children in Asia, "Peach in Asia study project"



ASPA 2023
Moving forward plans
GO
• Future Collaborations with research committees of other anesthesia societies
- To participate in the CRICKET (CRItiCal events in anaesthetised Kids undergoing Elective or emergency Tracheal intubation) project
• Launching novel research projects beyond borders (e.g. web-based surveys...)
• Holding a webinar regarding basics of research methods and biostatistics



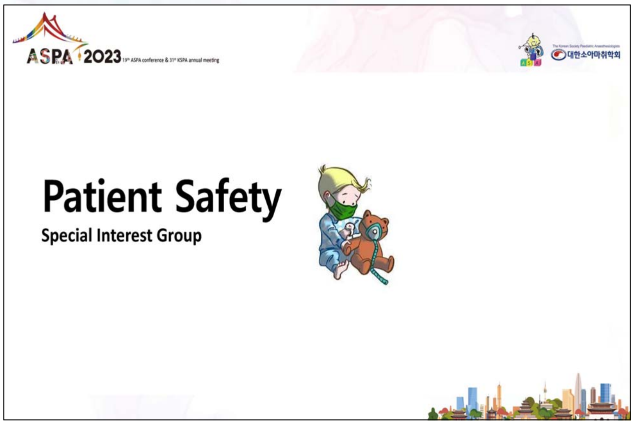
Asian Society of Paediatric Anaesthesiologist
Cardiac
Special Interest Group
Cardiac SIG Sign Up
Paediatric cardiac anaesthesiologists are a small group.
Collective knowledge and group wisdom is the way forward
The Vision:
A platform to share insights and expertise with the vision of improving standards of paediatric cardiac care in the region.



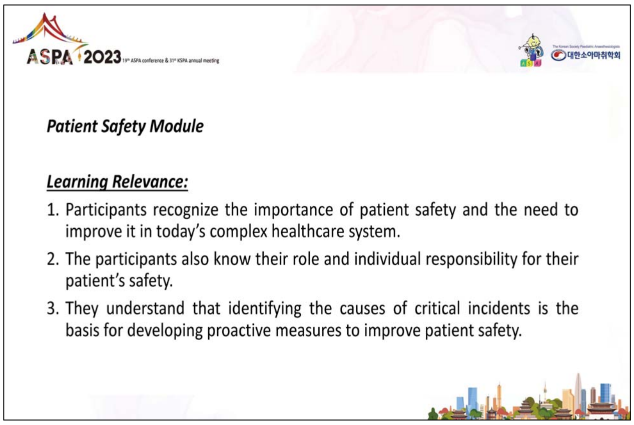
ASPA 2023
Cardiac SIG members
Cindy Boom
Yunita Widya
Evangeline Villa
Gina Gumintad
Dilek Altun
Kamlesh Tailor
Raj Sahajanandan
Shreedhar S Joshi
Unnikrishnan KP
Varsha A V
Angela Tan
Josephine Tan
Satish Reddy
Swapna Thampi
Tracy Tan
Hang Nguyen
Thao Giang
Nghi Huynh Bao Phan
Kelvin Ng
Maliwan Oofuvong
Suneerat Kongsayreepong
Wanutchaporn Sujaritttham
Kevin Umani

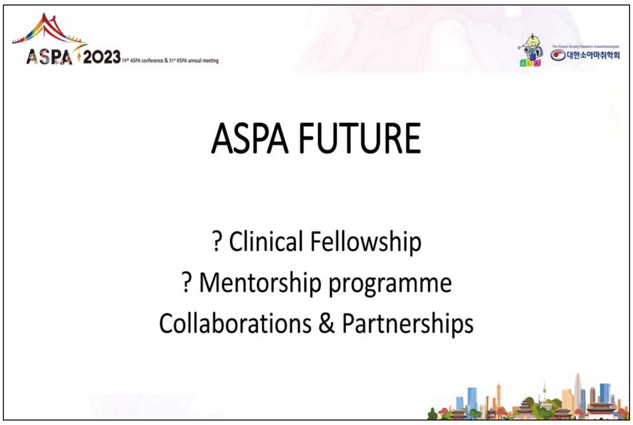
Asian Society of Paediatric Anaesthesiologists
ASPA Cardiac SIG Forum
11th March 2023 (Saturday)
Children with Congenital Heart Disease for Non- Cardiac Surgery
Speakers:
Moderators
Inaugural Cardiac SIG webinar – led by team from Thailand

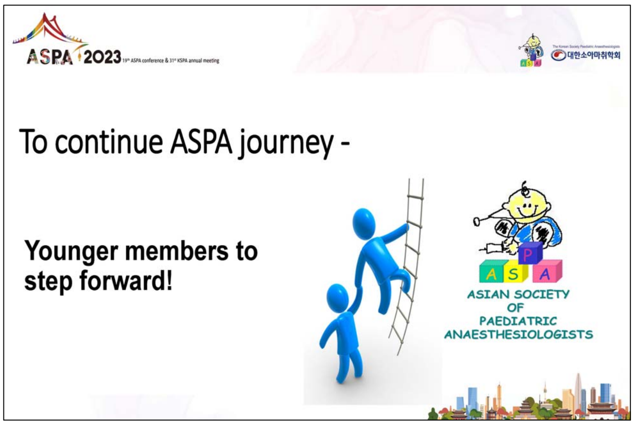
ASPA 2023
SIG activities
ASPA Cardiac SIG Forum
Children with Congenital Heart Disease for Non- Cardiac Surgery
Children with Congenital Heart Disease for Non-Cardiac Surgery (Part 2)
29 April 2023
Speakers
Upcoming Talks
2-part talk on Issues in ICU after Cardiac Surgery
12th August 2023
9th September 2023

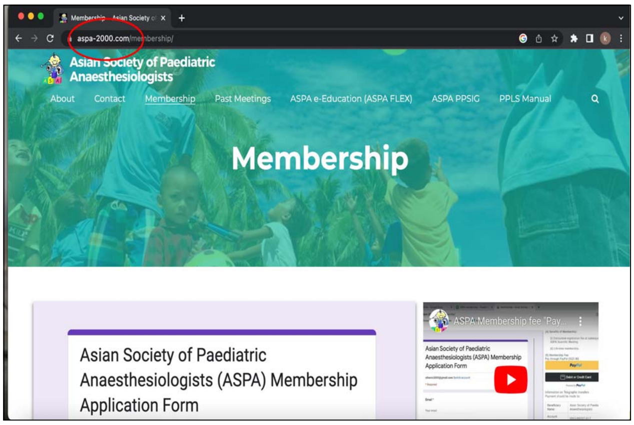

ASPA 2023
Patient Safety
Special Interest Group

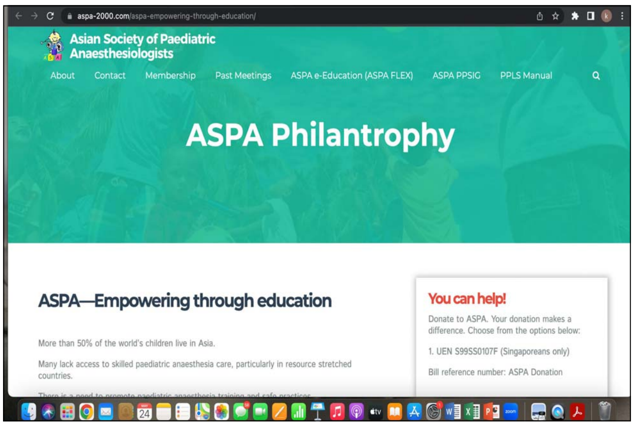

ASPA 2023
Members
• Canan Bor (Turkey)
• Angelina Gapay (Philippines)
• Rebecca Jacob (India)
• Arif HM Marsaban (Indonesia)
• Siow Yew Nam (Singapore)
• Erlinda Oracion (Philippines) - Lead
• Sana Urooj Shaheer (Pakistan)
• Shu Ching Teo (Malaysia)
• Josephine Tan (Singapore)


ASPA 2023
Patient Safety Module
Learning Relevance:
1. Participants recognize the importance of patient safety and the need to improve it in today's complex healthcare system.
2. The participants also know their role and individual responsibility for their patient's safety.
3. They understand that identifying the causes of critical incidents is the basis for developing proactive measures to improve patient safety.


ASPA 2023
ASPA FUTURE
? Clinical Fellowship
? Mentorship programme
Collaborations & Partnerships


ASPA 2023
To continue ASPA journey -
Younger members to step forward!
ASIAN SOCIETY OF PAEDIATRIC ANAESTHESIOLOGISTS


aspa-2000.com/membership/
Asian Society of Paediatric Anaesthesiologists
About
Contact
Membership
Past Meetings
ASPA e-Education (ASPA FLEX)
ASPA PPSIG
PPLS Manual
Membership
Asian Society of Paediatric Anaesthesiologists (ASPA) Membership Application Form


aspa-2000.com/aspa-empowering-through-education/
Asian Society of Paediatric Anaesthesiologists
About
Contact
Membership
Past Meetings
ASPA e-Education (ASPA FLEX)
ASPA PPSIG
PPLS Manual
ASPA Philantrophy
ASPA—Empowering through education
More than 50% of the world's children live in Asia.
Many lack access to skilled paediatric anaesthesia care, particularly in resource stretched countries.
You can help!
Donate to ASPA. Your donation makes a difference. Choose from the options below:
1. UEN S99SS0107F (Singaporeans only)
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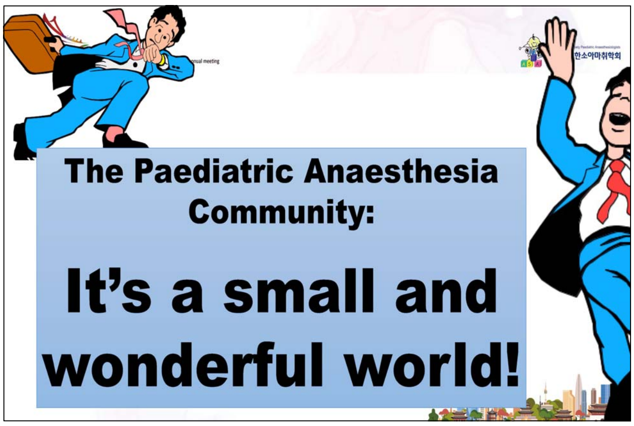

The Paediatric Anaesthesia Community:
It's a small and wonderful world!


ASPA 2023
Children in Asia receive safe anaesthesia care at any time, any place ...

ESPA: How to Collaborate Internationally and Intercontinentally

Jurgen C. de Graaff

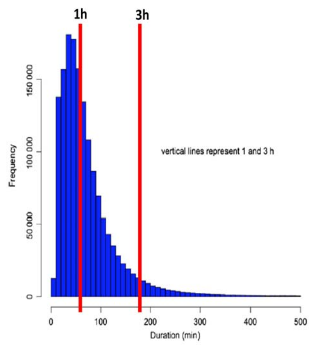
Erasmus Medical Center, Netherlands

Anesthesia in children is common!

- One in 7 children were exposed to general anesthesia before age 3 yrs.
  = 4 children per class/24 children

Shi et al. Ped Anesth, 2018: 513-519

Most anesthetics in children are short



Bartels Ped Anesth 2018

What do we measure
Neonates ≠ Infants ≠ Children ≠ Adolescents

- Mortality
- Morbidity
  - less clearly defined compared to mortality

Overall perioperative Morbidity:

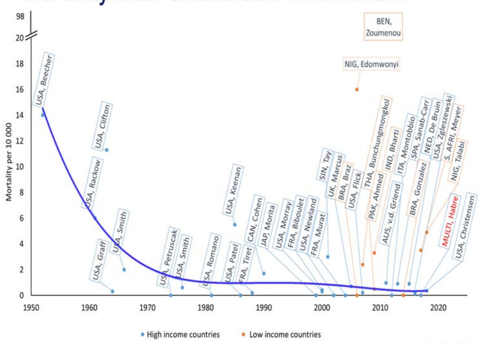
	Adults	Pediatrics
Mortality	1-4%	?
Myocardial infarction	1-3%	?
Stroke	0.1-0.7%	?
ARDS	0.2%	?
Acute kidney injury	1%	?

EuSOS-cohort, Pearse Lancet. 2012 Sep 22; 380(9847): 1059–1065.

Pediatric perioperative outcomes are different...
Neonates ≠ Infants ≠ Children ≠ Adolescents

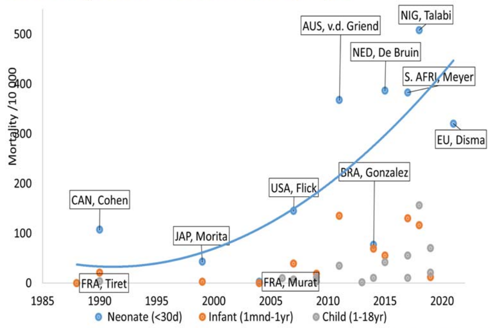
Adults	Children
• Mortality	• Rare
• Myocardial infarction	• Rare
• Kidney failure	• Rare
• Perioperative stroke	• Rare
• Thromboembolism	• Rare
• Postoperative cognitive decline	• Postoperative behavior change
• Return to work	• Emergence delirium
	• Parent proxy outcome measures
	• Developmental/age-specific measures

Mortality after anesthesia in children?



de Graaff Best Pract Res Clin Anesth 2021

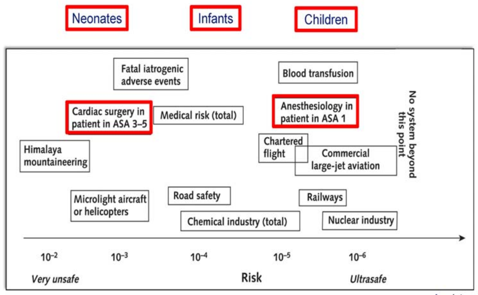
Mortality after anesthesia by age



de Graaff Best Pract Res Clin Anesth 2021

Five System Barriers to Achieving Ultrasafe Health Care

René Amalberti, MD, PhD; Yves Auroy, MD; Don Berwick, MD, MPP; and Paul Barach, MD, MPH



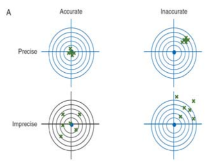
Ann Intern Med. 2005;142:756-764.

Study design

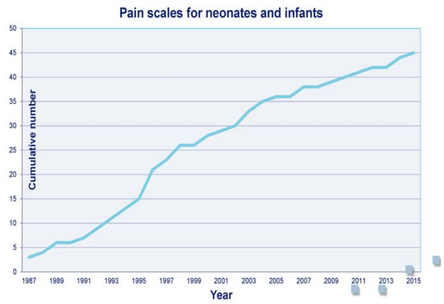
- Define aim study!
- Define primary outcome!
- Frequency outcome?
- Sample
  - Age
  - Location
- Sample size
- Tool outcome maesure

How do we measure outcome?

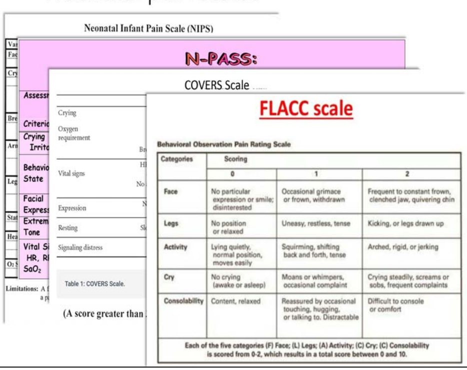
- Definition of outcome?
- Clinical relevance
- Defined minimal clinically important difference
- Metric properties
  - Validity
  - Reliability
  - Utility
  - Responsiveness



Number of pain scales for neonates and infants



Neonatal pain scales



Selection of pain instruments for (premature) neonates

Pain assessment instruments neonates	First author, year of first publication	Type of pain I procedural II postoperative III prolonged	Facial Expression	Body movement	Posture/ tone	Cry/ vocal	Behavioural state sleep pattern	Physiology	Conso-lability
NIPS	Lawrence et al, 1993	I	v	vv		v	v	v	
BPS	Pokela et al 1995	I	v	v	v				v
CRIES	Krechel et al, 1995	II	v			v	v	vv	
PIPP	Stevens et al, 1996	I / II	vvv				v	vv	
DAN	Carbajal et al 1997	I	v	v		v			
COMFORT-B	Van Dijk et al, 2000	II, sedation	v	v	v	v	v		
CHIPPS	Büttner et al, 2000	II	v	vv	v	v			
EDIN	Debillon et al, 2001	III	v	v			v		v
BPNS	Cignacco et al 2004	I	v		v	v	v	vv	v
BIIP	Holsti et al, 2007	I	vvvvv	vv			v		
N-PASS	Hummel et al, 2008	II/III, sedation	v		v	v	v	vvvv	
COMFORTneo	Van Dijk et al, 2009	II, III	v	v	v	v	v		
			100%	83%		67%	75%	42%	25%

Problems

- Large variability
- Large variation
- Difficult Meta-analysis
  - Variability undermines systematic reviews & meta-analyses
- Difficult combined outcome measures
- Selective outcome reporting
  - Report only outcomes of statistical or 'clinical' significance.

Advantages of core outcome sets

- Increases consistency across trials
- Maximise potential for trial to contribute to systematic reviews of these key outcomes
- Much more likely to measure appropriate outcomes
- Major reduction in selective reporting

Core outcome set:

An agreed standardized set of outcomes that should be measured and reported, as a minimum, in all clinical trials in specific areas of health or health care

COMET INITIATIVE

Core Outcome Measures in Effectiveness Trials

www.comet-initiative.org
Twitter: @COMETinitiative

COMPAC
Core Outcome Measures in Perioperative and Anaesthetic Care

Standardizing end points in perioperative trials: towards a core and extended outcome set

P. S. Myles[1,*], M. P. W. Grocott[2,3,4,5], O. Boney[2,5] and S. R. Moonesinghe[2,5], on behalf of the COMPAC-StEP Group

British Journal of Anaesthesia 116 (5): 586–9 (2016)

Pediatric Perioperative Outcomes Group (PPOG)

EDITORIAL

WILEY Pediatric Anesthesia

Pediatric perioperative outcomes group: Defining core outcomes for pediatric anesthesia and perioperative medicine

Paul A. Stricker[1]
Jurgen C. de Graaff[2]
Laszlo Vutskits[3]
Wallis T. Muhly[1]
Ting Xu[4]
Alexandra M. Torborg[5]
Yifei Jiang[6]
Suellen M. Walker[7]

Goal Representation:

- Europe
- United Kingdom
- China
- South Africa
- Australia
- New Zealand
- United States
- India
- Colombia
- Canada

DOI: 10.1111/pan.13354

EDITORIAL

WILEY Pediatric Anesthesia

Pediatric perioperative outcomes group: Defining core outcomes for pediatric anesthesia and perioperative medicine

In 2015, the joint National Institute of Academic Anaesthesia/James Lind Alliance Research Priority Setting Partnership published a top 10 list of research priorities for anesthesia and perioperative care in the UK.[1] These priorities were developed through a systematic process that engaged physicians, patients, and the public with the intent of identifying research questions broadly relevant to pertinent stakeholders. A subsequent editorial in this journal highlighted 4 priorities applicable to the care of children.[2]

One of the questions relevant to both adults and children was "What outcomes should we use to measure the 'success' of anesthesia and perioperative care?" However, this research priority generates many more questions: What outcomes matter most to our patients and their families? What outcomes are most important to clinicians? What are the fundamental outcomes for clinical researchers? Are these outcomes aligned? Do we and can we routinely measure these outcomes, either in clinical practice or in clinical trials?

Core outcome sets have been developed to address these questions across a wide range of medical disciplines. Consensus-based standardized outcomes are defined with the aim of reducing variability in the use and reporting of outcomes in clinical trials. In 2010, The Core Outcome Measures in Effectiveness Trials (COMET) initia-

the same "outcome" is used, variability in how that outcome is defined can make comparison of different trial results difficult. The use of standardized outcomes would greatly enhance the value of individual study results by enabling them to be seamlessly integrated into meta-analyses. The ability to combine results of multiple trials also helps address an ethical obligation of clinical research by enhancing the benefits and generalizability of data derived from human subject participation in research and minimizing unnecessary duplication.

Using COMET methodology, a core outcome set for adult perioperative medicine is being developed by a group of perioperative medicine clinicians and researchers. This initiative is described in greater detail elsewhere,[4,5] but in essence there are 2 parallel projects. COMPAC (Core Outcome Measures for Perioperative and Anesthetic Care) is a collaborative effort that seeks input from patients, care givers, nurses, and physicians to determine what outcome domains should be included in a perioperative core outcome set. The parallel StEP (Standardizing Endpoints in Perioperative medicine) project is an expert-based Delphi consensus-driven effort to define how the specific outcomes within these domains should be measured.[5]

Both COMPAC and StEP focus on perioperative care of adults having major surgery, and as such many of the outcomes are more

SPECIAL INTEREST ARTICLE

Pediatric Anesthesia WILEY

Pediatric Anesthesia. 2020;30:1166–1182.

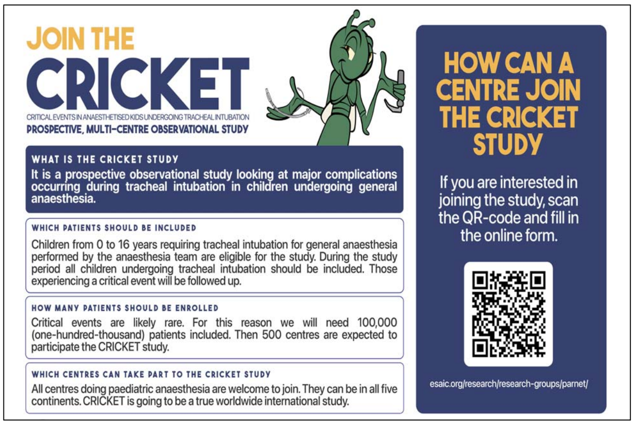
A systematic review of outcomes reported in pediatric perioperative research: A report from the Pediatric Perioperative Outcomes Group

Wallis T. Muhly[1] | Elsa Taylor[2] | Cyrus Razavi[3,4] | Suellen M. Walker[5,6] | Lei Yang[7] | Jurgen C. de Graaff[8] | Laszlo Vutskits[9] | Andrew Davidson[10,11,12] | Yunxia Zuo[7] | Carolina Pérez-Pradilla[13] | Piedad Echeverry[13] | Alexandra M. Torborg[14] | Ting Xu[15] | Ellen Rawlinson[6] | Rajeev Subramanyam[1] | Simon Whyte[16] | Robert Seal[17] | Heidi M. Meyer[18] | Sandhya Yaddanapudi[19] | Susan M. Goobie[20] | Joseph P. Cravero[20] | Aideen Keaney[21] | M. Ruth Graham[22] | Tania Ramos[23] | Paul A. Stricker[1] | on behalf of The Pediatric Perioperative Outcomes Group

How to collaborate?

- Clear Aim
- Accurate & precise international primary outcome
- Accurate sample size
- Define cohort
- Sample size
- Start simple, not too much!
- Work together and enjoy

- Have fun!



Session 2.

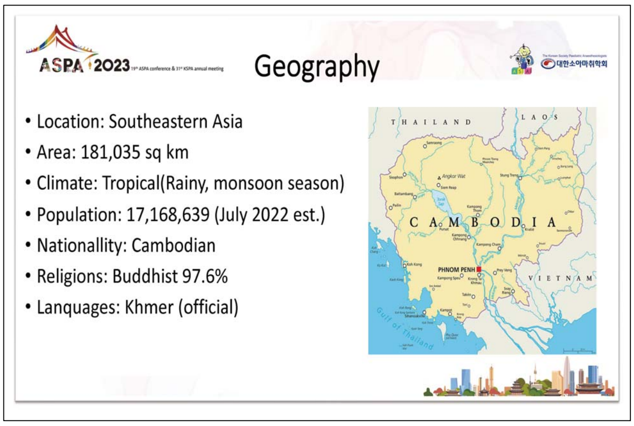
WFSA Panel Discussion: Universal Coverage of Safe Pediatric Anesthesia All Over Asia

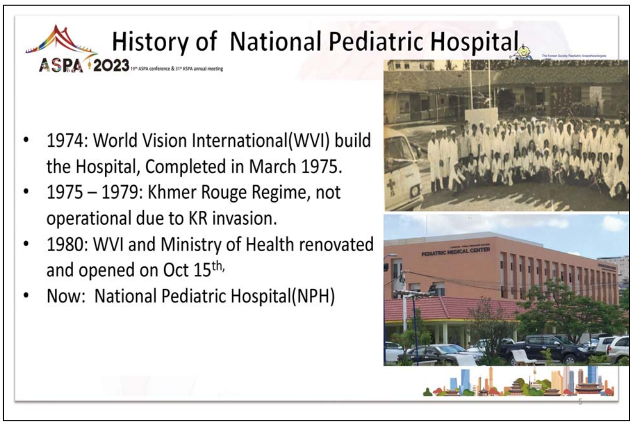
Chair(s): Erlinda Oracion (Philippines)
Il-Ok Lee (Korea)

Universal Coverage of Safe Pediatric Anesthesia in Cambodia

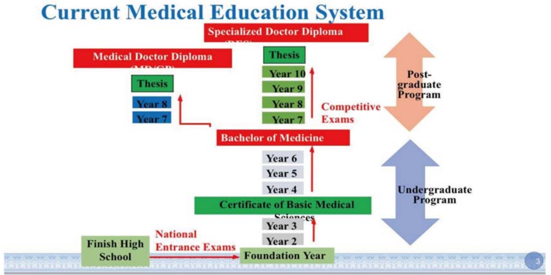
Sokha Tep

National Pediatric Hospital, University of Health Sciences, Cambodia





Current Medical Education System



Introduction

Brief introduction to the Current State of Pediatric Anesthesia in Cambodia:

=> Continuous medical education and development practice

=> Limited some essential equipment and medications

=> Substandard patient monitoring

=> Postoperative pain management can practice in few hospitals only.

=> The limited of subspecialized training in Cambodia

Current State of Pediatric Anesthesia in Cambodia(1)

- We have only 3 Pediatric hospitals that provide pediatric surgery services.
- Anesthesiologist provide pediatric anesthesia after short course training, or in hospital training only.
- We have limited some medication: neostigmine, naloxone, lipid emulsion(intralipid).
- Limit equipment using with small size in neonatal anesthesia.
- We still have nurse anesthetist providers in most hospital to care child under anesthesia.

Current State of Pediatric Anesthesia in Cambodia(2)

- We faced with old monitors because the new is expensive.
- We work with substandard equipment and try to provide the quality of child care services.
- We work and traine medical doctor to be pediatric anesthetist in operative theater then send to other training center oversea.
- With pediatric anesthesia, we don't have specific curriculum in training yet.

Success Stories and Best Practices in Cambodia

=> FIDR(Foundation International Delovement/Relief:Japan): Pediatric Anesthesia Course :2010-2015

=> In-hospital training then apply to traine in other country World Federation Society of Anesthesiologists as Bangkok Anesthesia Regional Training Center fellowship(1 year) to be anesthesiologist

=> Safe Pediatric anesthesia workshop training in Phnom Penh, Cambodia, 2022

=> Specialized 4 years training in University of Health Science after competitive exam from Medical Doctor/Bachelor of medicine.

Barriers to Universal Coverage of Safe Pediatric Anesthesia in Asia

- We have limited training of pediatric anesthesia in lower income countries(Cambodia, ...)
- Deficits in anesthesia infra structure, equipment and drugs.
- Asian countries doesn't have standard protocol practice.

To be better in future:

- We would like to request ASPA countries and members to support and anesthesia training in Asia regularly.
- Request Asian medical companies to supply low price.
- Asian countries should have standard protocols in pediatric practice and do training to all Asian anethetists regulary.

Conclusion and Call to Action

Safe pediatric anesthesia providing is a bit far from expectation, so each hospital have to guide:

=> Minimal standard monitor for pediatric anesthesia in Cambodia: ECG, HR, pulse oxymeter, blood pressure, Temperature

=> Minimized using equipment, drugs and reversal agents.

=> to do bedside teaching and training regularly

=> to join pediatric course Oversea as possible as they can

=> Asian countries should have standard protocols in pediatric practice and do training to all asian anethetists in low income countries.

LOCAL PEDIATRIC ANESTHESIA TRAINING


Safe Paediatric Aesthestesia Course
in Cambodia,18-20 Nov 2022
ASPA 2023
대한소아마취학회

Current Status of Pediatric Anesthesia In Bangladesh Challenges and Opportunities for Improvement

Debabrata Banik

Department of Anesthesia, Analgesia and Intensive Care Medicine,
Bangubandhu Shiekh Mujib Medical University, Bangladesh

Bangabandhu Sheikh Mujib Medical University Super Specialised Hospital
BSMMU & South Korean project

Bangubandhu Shiekh Mujib Medical University : Center for all post graduate medical education

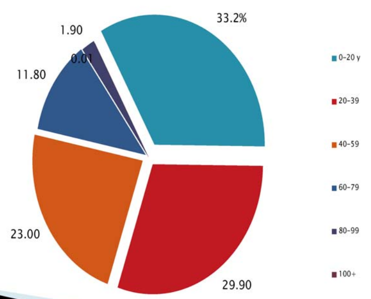
Health care facilities and indicator

- Bangladesh has a good healthcare network covering both rural and urban areas, (Health care facilities 3976 in public sector 975 in privates with 0.79 bed per 1000) and comparable to other Asian country with little difference in level of care – most difference in Skill due to lack of facility
- This country is hugely populated (1252 sq km with about 17 crore) which is 2.2 % whole world population

Demography of Pediatric population in Bangladesh

Birth rate:	17.71/ 1000 population
Death rate	5.54/1000
Infant mortality :	22.9- 24.73/1000 live
Mortality under 5 year	27.27- 38/1000 live
Neonatal mortality	16 -20/ 1000 live birth
Anesthesiology Man power	1.2 / 100000
Pediatric Anesthesiologist :	Not defined

Population distribution / 1/3 pediatric population



Hospital facility for Pediatric surgical patient

BSMMU : Different pediatric surgical subspecialty including pediatric cardiac surgery.

All government medical college (n-38) : Pediatric surgery Bed 10 to 30 bed /500 to 1000 bed hospital.

Child and maternal hospital
(1) 30 bed Shishu hospital.
(2) 50 bed.
Pediatric cardiac surgery Limited Bed

All above have a separate pediatric surgical unit

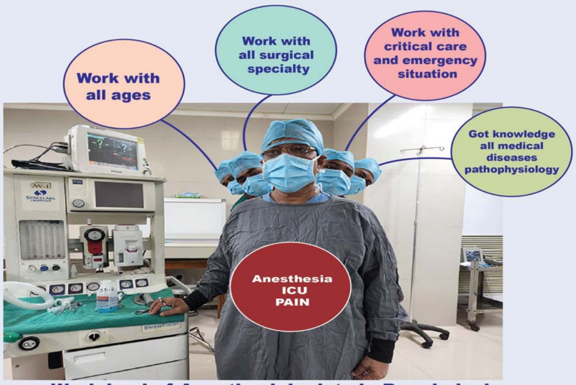
Privative Clinic or Hospital: No definite pediatric surgical ward.

NICU And PICU : PICU very limited compare to NICU

Every Anesthesiologist All over the world

Anesthesia

- Anesthesiology is one of the most demanding and essential specialty of modern medical science not only to provide anesthesia for surgical operation but also involve in the management of different medical condition.
- Anesthesiology is the largest single hospital specialty.
- But is probably the least well understood in the developing counties like Bangladesh



Work load of Anesthesiologists in Bangladesh

Anesthesia

- Anesthesiologists treat patients of all ages with a variety of medical problems.
- Anesthesiologists provides anesthesia operate on wide range of cases, from heart and brain procedures to births and catastrophes.

Anesthesia

- In reality- Anesthesia is a rewarding and challenging specialty and acute in nature.
- It is truly one of the few specialties where decisions made in critical situations can mean the difference between "life and death."
- Among anesthesia specialty- pediatric anesthesia is more risky than other specialty

DS (Child) H J 2018; 34(1) : 3-4

LEADING ARTICLE

History of Pediatric Anesthesia in Bangladesh

Md. Shahidul Islam

Children are very special people who require special care in order to provide safe anesthesia. The history of pediatric anesthesia is the steps towards maintaining normal limits of neurologic, respiratory, cardiovascular and other body systems. The goal of the specialty of the pediatric anesthesiology is the reduction of perioperative morbidity and mortality and promotion of monitoring, resuscitation and supportive fields through teaching, research, organizational activity throughout the world.[1,2] Before discussing the history of pediatric anesthesia in Bangladesh I want to discuss what was the global condition. Before introduction of ether in 1846, circumcision, believed that the development of modern pediatric anesthesia started in 1930.[8] The rapid growth of pediatric anesthesia was divided into two chronological categories. First were 1930 to 1950 and the second 1950 to present. During the first period the anesthesia techniques and equipment were developed. In the second phase with further techniques, equipment, refinement, modern anesthetics and vital system monitoring were introduced into everyday practice.[9] Ether and chloroform could be given for orthopedic and limb surgery but problems were with cleft lip, palate, abdominal, ENT and chest surgery.[10] Digital tracheal intubation with a soft rubber catheter was

The history of pediatric anesthesia

- The history of pediatric anesthesia in Bangladesh was miserable.
- In early 1970 's the only agent was ether and chloroform to anesthetize the pediatric patient.
- Pediatric endotracheal tube, laryngoscope, pediatric circuit and IV cannula was available late 1980
- Pediatric surgeon and pediatric anesthetists were not available before 1980
- Mortality rate was very high due to aspiration and respiratory depression in 1970 1980
- The condition was horrible for the anesthetists and surgeon.

The history of pediatric anesthesia in Bangladesh

- Individual pediatric surgery started after 1980
- Before 1980 all pediatric surgery was done by general surgeon
- 1980 to 2000 pediatric anesthesia started to provided by qualified senior anesthesiologist

Debabrata Banik: Current Status of Pediatric Anesthesia In Bangladesh Challenges and Opportunities for Improvement

History of pediatric Anesthesia In Bangladesh

- But morbidity and mortality was high due to lack proper skill and institutional support.
- One study support only 13% qualified anesthesiologist provide safe pediatric anesthesia .
- Revolution for Specialty anesthesia started after 2000.
- When the patient safety is a pioneer and more medico legal issue came out -- Improved Action plan start

Development of Specialty

- **Safety Issue:** Today high profile advances in surgical practice mostly depends on efficient and effective methods of anesthesia and intensive care medicine.
- More and more safety is a crucial point for surgical patient .
- So on this point surgical specialty divided into different surgical sub specialties and super specialties for more skill and successful outcome

Development of Specialty

- The American College of Surgeons recognizes **14** surgical specialties:
- and in Royal college of Surgeon UK recognized 10 surgical specialties,
- With this changes in developed country was initiate the development of anesthesia subspecialty.
- Among them Pediatric anesthesia is most important subspecialty and it is different in all respect

Development of Specialty

- In Bangladesh 17 surgical specialty with different division were created.
- Dental and medical faculty also divided into many subspecialy.
- However, in Bangladesh single Anesthesiologists have to performed wide range of clinical practice related to all surgical specialties for a long period
- So there is less scope to anesthesiologist to develop skill and Knowledge on a specific surgical specialty.

Development of Specialty

- There were confidential report in Bangladesh that if anesthesia provided by specific subject specialty outcome is better in respect of morbidity and mortality.
- Pediatric Anesthesiologists works in more urgent and risky conditions specially neonatal surgery

. There is limited anesthetists are able to provide safe anesthesia for children.

Pediatr Clin North Am 1994; **41**: 1-14

MedCrave Journal of Anesthesia & Critical Care: Open Access

Review Article

Open Access CrossMark

Issues and challenges of pediatric anesthesia in Bangladesh

Abstract

Geographically Bangladesh is located in an area where natural calamities like flood, cyclone, and drought are very common. The country is hugely populated (1252/Sq km) due to its livable plain terrain with a good reserve of natural resources but as usual, we have a developing health management system. So, as a non-earning member of family women and children is the most vulnerable group of society. Children constitute more than one third (51.3million) of total population on the other hand woman constitute almost half (49.40%) as well. Due to low Gross Domestic Product (GDP), allocation of budget in health (0.92% of GDP) specifically for addressing children and maternal health is not sufficient. Despite the diversity in their geographical, linguistic, and political structures, Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka face common health challenges. Moreover socioeconomic status of these countries differs very little, even though Bangladesh had achieved United Nations Award for successful reduction of infant (28.2/1000) and maternal mortality rate (170/1000) on Millennium Development Goals-4 during the 65th United Nations General Assembly.

Combined Military Hospital, Dhaka is a 1500 beds tertiary care teaching hospital which has 30 beds pediatric surgery ward, 130 beds pediatric medical ward, 10 beds neonatal ICU, 10 beds pediatric ICU and 36 beds adult ICU as well. On an average 100

Volume 10 Issue 6 - 2018

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- After 2000 1st Pediatric anesthesia workshop was arranged with the help of WFSA and faculty was Prof Dilip Power from India
- Includes Pediatric anesthesia in Every post gradute training and course like DA,MD and FCPS

Pediatric anesthesia and Surgery - Outcome

Statistics of neonatal surgery in 2016 at Dhaka Shishu (Children) Hospital

Name of month	Total op	Total death
January	78	12
February	64	9
	62	13
March	60	10
April	67	14
May	70	13
June	74	11
July	69	9
August	72	10
September	66	8
October	57	6
Novembe	63	15
December		
Total	802	130 (16.20%)

Statistics of neonatal surgery from 2012 to 2016 at CMH, Dhaka

Year	Total op	Total death
2012	28	3
2013	31	5
2014	35	8
2015	43	7
2016	37	6
Total	174	29 (16.66)

High mortality rate in pediatric surgical patient

Causes of death in Dhaka children hospital 2016

- Delayed reporting sick and delayed intervention
- Complex medical diseases & co-morbidity
- Ongoing sepsis & multi-resistant organisms
- Hospital set-up is not well equipped
- Peripheral hospitals are neither well prepared & equipped
- Lack of trained staffs
- Maternal causes: poor nutrition, preterm, multiple pregnancies

Less skilled manpower specially anethesiologist ?
Overload of work for anethesiologist

Causes of death in military hospitals 2012 to 2016

- Military hospitals having a very effective chain of evacuation system from field hospital to base hospital
- Good infrastructure with excellent instrumental support
- Trained manpower
- Qualify Anesthesiologist

But mortality is same compare to other hospital

So patient factor and management protocol is very important

Not all related to anesthesia

Pediatric AnesthesiOlogist is providing different surgery of following Diseases with different surgical specialty

- Pediatric surgery
- Hernia . Esophageal atresia with/without fistula / Intestinal atresia. Billiary atresia or deformaty
- A diaphragmatic hernia ,Eventration of diaphragm
- Mesenteric cyst , Myelomeningocele
- Gastroschisis, Omphalocele PUV UDT ARM
- Hirschsprung's disease, Intussusceptions, Rectal polyp
- IHPS. Hydrocephalus, Hypospadias, Tongue tie
- Appendicitis .Cholecystectomy . Child hood cancer etc.

CURRENT STATUS OF PEDIATRIC ANESTHESIA IN BANGLADESH

Rare cerebrovascular disease MOYAMOYA mandates anaesthesiologists to formulate an individualized anaesthetic plan for these patient

Common Surgical procedure in pediatric patient in Bangladesh

Pediatric Anesthesia is providing in the different surgery with following Diseases or specialty

ENT :- Adeniodectitomy Tonsellectomy / Mostiodectomy

- **Orthropedric :-** Correction of structure abnormality, Trauma
- **Neurosurgery :-** Conginital Hydrocephalus ,Miningocel, Brain tumor
- **Endo Leparoscopic :-**Lap Chol,Appen, ERCP, Spleenectomy
- **Anesthesia outsite operation theater:-** CT scan MRI,Endoscope ,Bronchoscope
- **Plastric Surgery :-** Cleft lip ,plalete other stuctural abnormal or burn or burn contrcture
- **Pediatric kidney Transplant** :- Kidney transplant
- **Pediatric cardiac surgery** : Correction of congenital cardiac disease . Open heart surgery ,Non invasive procedure

---

Common anesthetic Technique in Pediatric surgery

Mostly Provide General anesthesia with or with out tracheal intubation.

Regional anesthesia combined General anesthesia or independent in specific and limited surgery .

Among them caudal , spinal is commonly practice

Monitoring anesthesia or proper way of sedation anesthesia of pediatric patient is less practice

---

Common anesthetic Technique in Pediatric surgery

Anesthetic Drugs

IV induction TPS, Propafol Ketamine
Inhalation :Halothan ,Isoflurene and Sevoflurane

Opiod : Pethedine and Fentanyl

Muscle ralaxant ; Suxa, Rocurium,Vecurium Atracurium

Local Anesthetic : Lignocaine , Bupivacaine

Monitoring : Clinical.SPO2.BP ECG Limited ETCO2 Precordial Stethoscope

Per operative Fluid :open

Post operative Analgesic : Paracetamol, NSAID , Pethedine and caudal block

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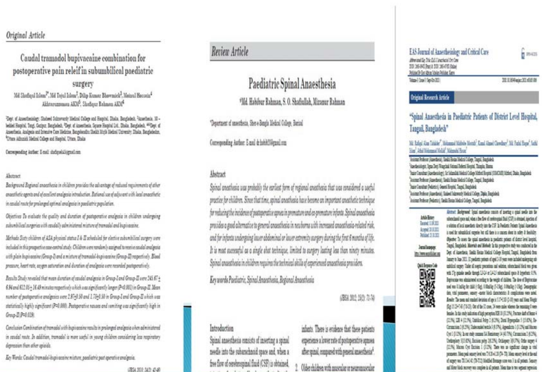


Original Article

Caudal tramadol bupivacaine combination for postoperative pain relief in subumbilical poediatric surgery

Review Article

Paediatric Spinal Anaesthesia

Original Research Article

Spinal Anesthesia in Paediatric Patients of District Level Hospital, Tangail, Bangladesh

CURRENT STATUS OF PEDIATRIC ANESTHESIA IN BANGLADESH

- Pediatric patient is not a miniature of adult
- So it needs special knowledge and skill to provide safe pediatric anesthesia
- Pediatric anesthesia can be divided into three group Intrauterine life ,neonatal and infant to adolescent
- Considering this: BSA-CCPP and university take some initiative to improve by providing short term training and organised SAFE pediatric courses.
- One international workshop arranged - Faculty Prof Dilip Power in 2000 supported by WFSA.
- Arranged Three SAFE course: Faculty from UK, Australia and IRLAND supported by WSFA and AAIB -2012 to2020
- After this there may reduced mortality but not morbidity which reflect in recent studies

SAFE PEDIATRIC Course

EAS Journal of Anaesthesiology and Critical Care

Abbreviated Key Title: EAS J Anesthesiol Crit Care

ISSN: 2663-094X (Print) & ISSN: 2663-676X (Online)

Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-5 | Issue-1 | Jan-Feb-2023 | DOI: 10.36349/easjacc.2023.v05i01.001

Original Research Article

Complication of Anesthesia in Children: A Prospective Observational Study

Dr. Asma Afroz[1*], Dr. Rehan Uddin Khan[2], Dr. Chandra Shekhor Kormokar[3]

[1]Assistant Professor, Department of Aneaesthesia, ICU & Pain Medicine, Shaheed Suharawardy Medical College and Hospital, Dhaka, Bangladesh

[2]Associate Professor, Department of Aneaesthesia, ICU & Pain Medicine, Shaheed Suharawardy Medical College and Hospital, Dhaka, Bangladesh

[3]Assistant Professor, Department of Aneaesthesia, ICU & Pain Medicine, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh

Article History

Abstract: ***Background:*** Any anaesthetic procedure, either regional or general, has some potential for complications. For this reason, careful preoperative assessment

Patient status according to ASA

shaheed Suharawardy Medical College and Hospital, Dhaka, Bangladesh January 2018 to December 2018

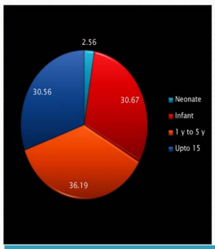
ASA Score	n	%
ASA I	42	68%
ASA II	12	19%
ASA III	4	7%
ASA IV	2	3%
ASA V	2	3%
	62	100%

BSMMU Year report 2021to 2022

ASA Score		
ASA I	1062	59.23%
ASA II	605	33.74%
ASA III	78	4.35%
ASA IV	16	0.89%
ASA V	2	0.11%
Emergency	30	1.69%
	1793	100%

Pediatric anesthesia in different aged group

Age –Shaheed Suharawardy Medical College and Hospital, Dhaka, Bangladesh January 2018 to December 2018



BSMMU 2021 to 2022

Pediatric anesthesia for different surgical speciality

Pediatric surgery bed 10

Surgical Procedures	n	%
General surgery	30	48%
ENT	11	18%
Orthopedics	8	13%
Maxillofacial	6	10%
Ophthalmic	5	8%
Cardiothoracic	2	3%
Total	62	100%

Pediatric surgery bed 40

Surgical Procedures		
Pediatric surgery Dept	1305	72 .78%
ENT	115	6.41%
Orthopedics	31	1.72%
Maxillofacial	2	0.11%
Ophthalmic	68	3.79%
Cardiothoracic/	30	1.67%
Urology	20	1.11%
Plastic Surgery	32	1.78%
Outside OT/ Procedural	190	9.92%
	1793	100%

Anesthetic technique

Anesthetic technique Medical college hospital

Technique	n	%
General anesthesia	54	871 %
General anesthesia & local infiltration	3	5%
General anesthesia & caudal block	4	6%
Subarachnoid block	1	2%

Technique		
General anesthesia	837	46.68%
General anesthesia & local infiltration	205	11.43%
General anesthesia & caudal block	408	22.75%
Subarachnoid block/epidural	172	9.59%
Monitoring anesthesia	171	9.53%

Morbidity in Pediatric Anesthesia

Per-operative Complication Medical college hospital

Complications	n 62	%
Bronchospam	7	11%
Bradycardia	6	10%
Hypotension	5	8%
Hypoventilation	4	6%
Tachycardia	4	6%
Laryngeal spasm	4	6%
Hypertension	4	6%
Apnoea	4	6%
Dysrrhythmia	3	5%
Total Morbidity	41	64%
Cardiac arrest table	2	3%

Complications	N 1703	%
Bronchospam	50	2.78%
Bradycardia	69	3,38%
Hypotension	67	3.73%
Hypoventilation/Inadequate ventilation	34	1.89%
Tachycardia	156	8.70%
Laryngeal spasm	57	3.17%
Hypertension	61	3.40%
Apnoea	5	0.27%
Dysrrhythmia	103	5.74%
Hypothermia	67	3.73%
Total	669	37,31%
Cardiac arrest On table	6	0.32%

Morbidity in Pediatric Anesthesia

Post-operative Complication
Medical college hospital

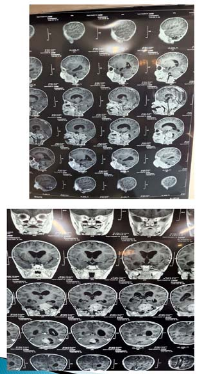
Complications	n	%
Tachycardia	12	19%
Prolonged unconsciousness	6	10%
Hypoventilation	5	8%
Restlessness	3	5%
Respiratory arrest	3	5%
Pain	3	5%
Shivering	3	5%
Hypotension	2	3%
Hypertension	2	3%
Hemorrhage	2	3%
Laryngospasm	2	3%
Bronchospasm	2	3%

Post-operative Complication : BSMMU

Complications	n1793	%
Air way obstruction//hypoximia	75	4.18
Tachycardia	185	10.31
Prolonged unconsciousness /delay recovery	45	2.50
Hypoventilation/hypoximia	105	5.85
Restlessness	209	11.65
Respiratory arrest	21	1.17
Pain inadequate controle	107	5.96
Shivering	121	6.74
Hypotension	81	4.51
Hypertension	65	3.62
Hemorrhage	43	2.39
Laryngospasm	67	3.73
Bronchospasm	75	4.18
Total	1132	63.13

Mortality Pediatric surgery IN BSMMU 2022

Age and group	N Operation done	Mortality	%
Neonatal	130	16	12.3%
Infant	579	3	0.51%
Pre school	583	2	0.34%
Aldocent	501	1	0.19%
Pediatric cardiac surgery	85	15	17.64%
On table mortality		2	All other in post operative period



BJA

British Journal of Anaesthesia, 126 (6): 1157–1172 (2021)

doi: 10.1016/j.bja.2021.02.016
Advance Access Publication Date: 1 April 2021
Paediatric Anaesthesia

PAEDIATRIC ANAESTHESIA

Morbidity and mortality after anaesthesia in early life: results of the European prospective multicentre observational study, neonate and children audit of anaesthesia practice in Europe (NECTARINE)

Nicola Disma[1,*], Francis Veyckemans[2], Katalin Virag[3], Tom G. Hansen[4,5], Karin Becke[6], Pierre Harlet[7], Laszlo Vutskits[8,9], Suellen M. Walker[10], Jurgen C. de Graaff[11], Marzena Zielinska[12], Dusica Simic[13], Thomas Engelhardt[14] and Walid Habre[8,9], for the NECTARINE Group of the European Society of Anaesthesiology Clinical Trial Network[†]

[1]Department of Anaesthesia, Unit for Research & Innovation, Istituto Giannina Gaslini, Genova, Italy, [2]Département d'Anaesthésie-Réanimation pédiatrique, Hôpital Jeanne de Flandre, CHRU de Lille, Lille, France, [3]Department of Medical Physics and Informatics, University of Szeged, Szeged, Hungary, [4]Department of Anaesthesia and Intensive Care -Paediatrics, Odense University Hospital, Odense, Denmark, [5]Department of Clinical Research - Anaesthesiology, University of Southern Denmark, Odense, Denmark, [6]Department of Anaesthesia and Intensive Care, Cnopf Children's Hospital/Hospital Hallerwiese, Nürnberg, Germany, [7]Research Department, European Society of Anaesthesiology,

Audit report on pediatric anesthesia

Critical events requiring intervention occurred in 35.2% of cases--

- Mainly hypotension (>30% decrease in blood pressure) or reduced oxygenation (SpO2 <85%).
- Postmenstrual age influenced the incidence and thresholds for intervention.
- Risk of critical events was increased by prior neonatal medical conditions, congenital anomalies, or both.

Audit report on pediatric anesthesia

- The incidence of peri-operative complications and mortality is higher in neonate and infant than in older children,
- Specific impact of anaesthesia technique and management has not been fully characterized.
- Alterations in perioperative physiological parameters have a significant factors affecting early and late neuro-developmental and health outcomes.

Challenges

1. Administrative and Financial
   a. Capacity building and organized health management system is still going on
   b. Socioeconomic status of Bangladesh is devoloping

2. Infrastructure : a. Many of our Hospital are inadequate for specialized facilities,
   b. Universal precaution and awareness for infection control is insufficient in theater & PICU, NICU

3. Shortage of Skill manpower , anesthesiologist and supporting staff.

4. **Need Motivation** and remunerations ,reorganization

5. Lack of Social awareness with various superstitions

6. **Government planning**

Opportunities For Improvement

- Regional and international co-operation is essential leaded by AAPA And WFSA
- Arrange Short term training program for qualifying anesthesiologist and OT and post operative nurses Like SAFE pediatric Courses
- Special training schedule in all post graduate program at least 3moonth to one year.
- Training exchange program within developed and developing Country
- One year fellowship program organized by BSMMU and scholarship from WFSA

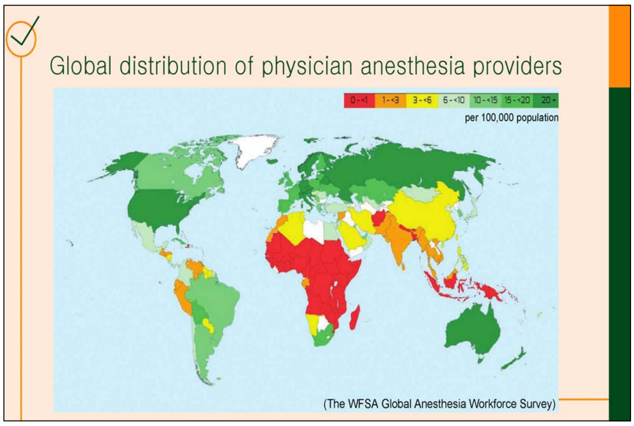
Recommendation/Conclusion

- Neonates and infants have limited physiological reserve, and carries high risk of complications with general anesthesia specially Premature neonates
- Present study quantifies the important physiological aberrations and their risk factors.
- A high degree of training and skill are required for safe delivery of anaesthesia for neonates and infants for specialised pediatric surgery

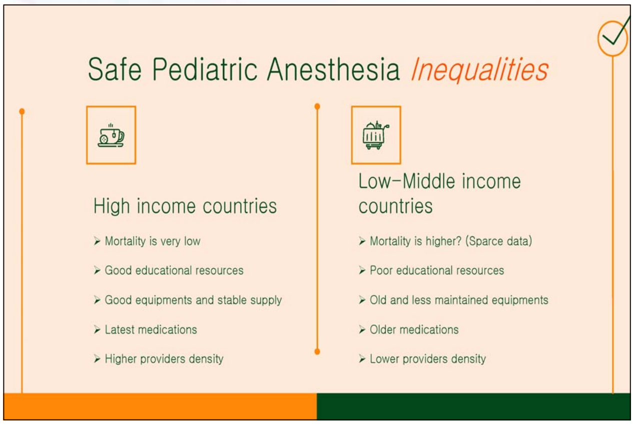
Universal Coverage of Safe Pediatric Anesthesia all over the World: WFSA pediatric Anesthesia Committee

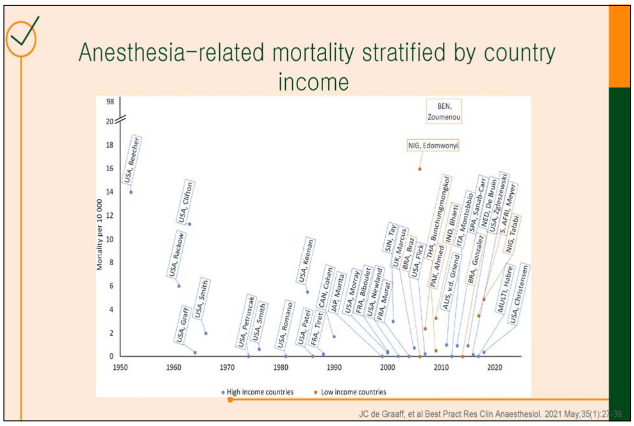
Norifumi Kuratani

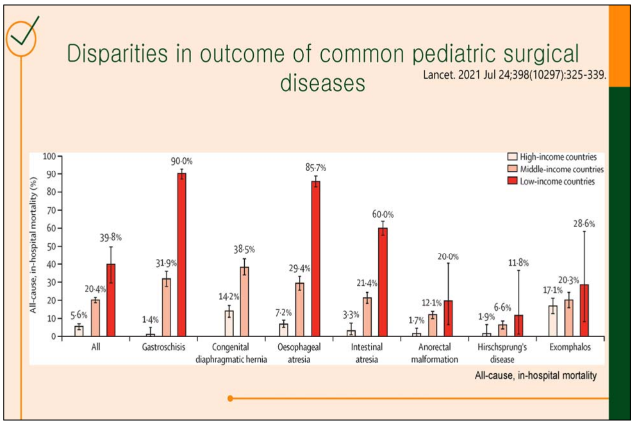
Saitama Children's Medical Center, Japan

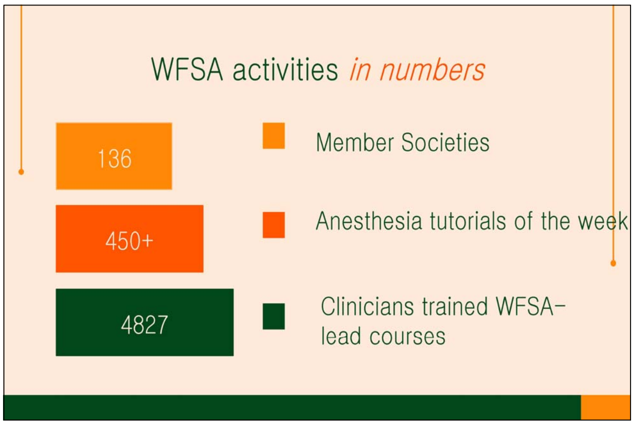


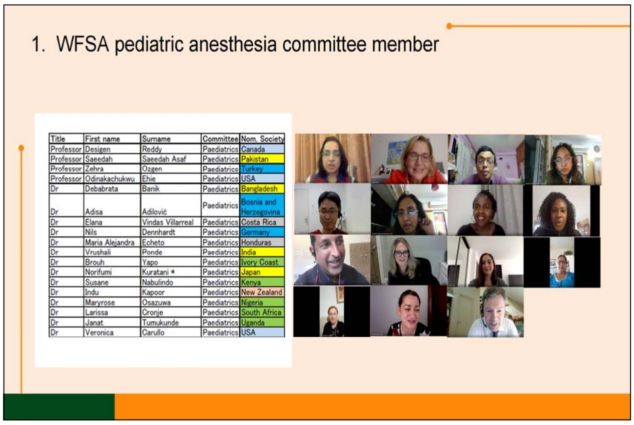
Norifumi Kuratani: Universal Coverage of Safe Pediatric Anesthesia all over the World: WFSA pediatric Anesthesia Committee





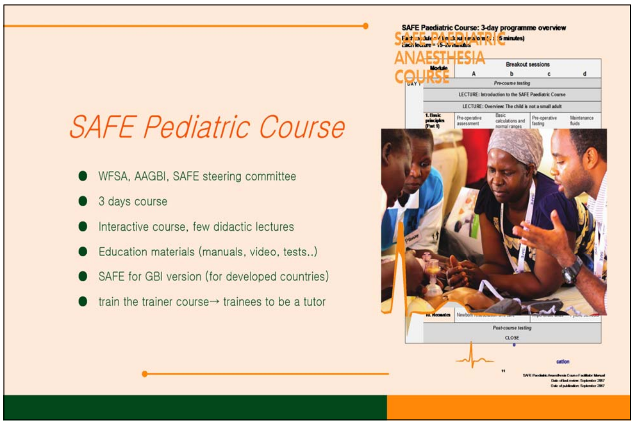




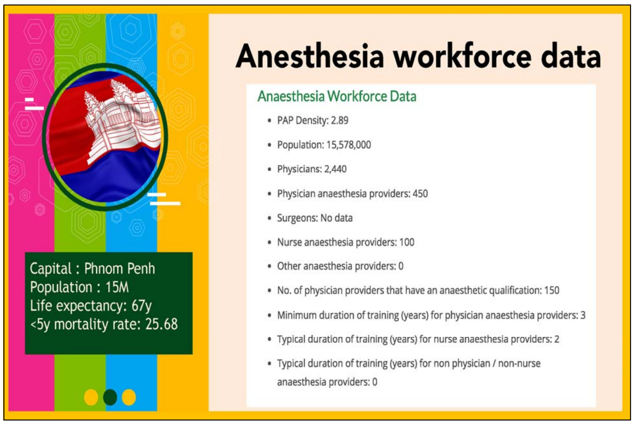


Title	First name	Surname	Committee	Nom. Society
Professor	Desigen	Reddy	Paediatrics	Canada
Professor	Saeedah	Saeedah Asaf	Paediatrics	Pakistan
Professor	Zehra	Ozgen	Paediatrics	Turkey
Professor	Odinakachukwu	Ehie	Paediatrics	USA
Dr	Debabrata	Banik	Paediatrics	Bangladesh
Dr	Adisa	Adilović	Paediatrics	Bosnia and Herzegovina
Dr	Elana	Vindas Villarreal	Paediatrics	Costa Rica
Dr	Nils	Dennhardt	Paediatrics	Germany
Dr	Maria Alejandra	Echeto	Paediatrics	Honduras
Dr	Vrushali	Ponde	Paediatrics	India
Dr	Brouh	Yapo	Paediatrics	Ivory Coast
Dr	Norifumi	Kuratani *	Paediatrics	Japan
Dr	Susane	Nabulindo	Paediatrics	Kenya
Dr	Indu	Kapoor	Paediatrics	New Zealand
Dr	Maryrose	Osazuwa	Paediatrics	Nigeria
Dr	Larissa	Cronje	Paediatrics	South Africa
Dr	Janat	Tumukunde	Paediatrics	Uganda
Dr	Veronica	Carullo	Paediatrics	USA


Ongoing Committee Projects
SAFE Course
Implementing SAFE pediatric anesthesia course all over the world
Textbook
Case-based pediatric anesthesia textbook authored by committee members
Webinars
Working together with ASPA providing educational resorces
Fellowship
Development of new pediatric anesthesia fellowship program in Bosnia and Herzegovina
PEACH
Epidemiologic study to learn the incidence of critical adverse events in pediatric anesthesia
Cancer Care
Anesthesia is important in pediatric oncology care


SAFE Pediatric Course
WFSA, AAGBI, SAFE steering committee
3 days course
Interactive course, few didactic lectures
Education materials (manuals, video, tests..)
SAFE for GBI version (for developed countries)
train the trainer course→ trainees to be a tutor
SAFE Paediatric Course: 3-day programme overview


SAFE pediatric anesthesia & ToT course in Cambodia
Nov. 18-20, 2022
Paediatric Anaesthetic and Train the Trainers Course
Date: 18th-20th November 2022
Phnom Penh Hotel, Phnom Penh City, Cambodia
Organized by
SAFE
Co-Organized by


Anesthesia workforce data
Capital : Phnom Penh
Population : 15M
Life expectancy: 67y
<5y mortality rate: 25.68
Anaesthesia Workforce Data
PAP Density: 2.89
Population: 15,578,000
Physicians: 2,440
Physician anaesthesia providers: 450
Surgeons: No data
Nurse anaesthesia providers: 100
Other anaesthesia providers: 0
No. of physician providers that have an anaesthetic qualification: 150
Minimum duration of training (years) for physician anaesthesia providers: 3
Typical duration of training (years) for nurse anaesthesia providers: 2
Typical duration of training (years) for non physician / non-nurse anaesthesia providers: 0


Faculties
Faculty leaders
Lowri Bowen (UK, SAFE steering committee)
Nori Kuratani (Japan, WFSA pediatric chair)
Tep Sokha (Cambodia, SCARMU)
UK:4, Japan:4, Cambodia:5
SAFE pediatric course
2 days course
5 lectures, 19 modules
26 local providers trained
Train the Trainer
1 day course
10 new trainers
WFSA
SAFE PAEDIATRICS
Association of Anaesthetists


Ongoing Committee Projects
SAFE Course
Implementing SAFE pediatric anesthesia course all over the world
Textbook
Case-based pediatric anesthesia textbook authored by committee members
Webinars
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Fellowship
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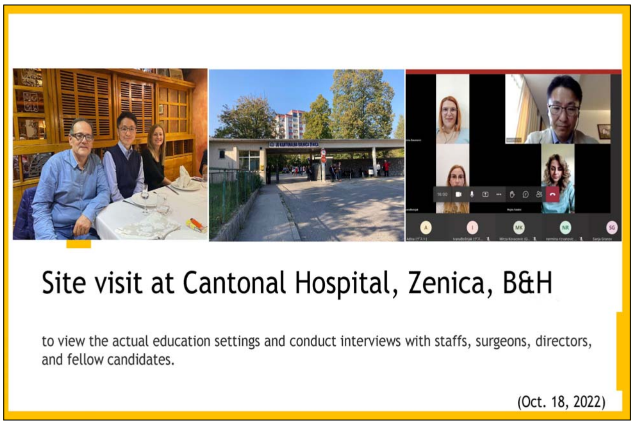
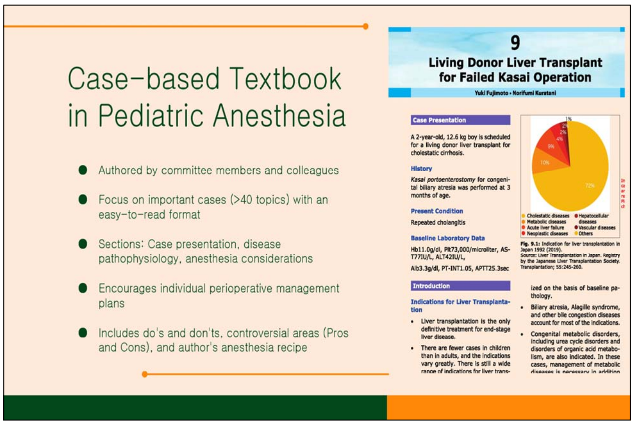
Epidemiologic study to learn the incidence of critical adverse events in pediatric anesthesia
Cancer Care
Anesthesia is important in pediatric oncology care

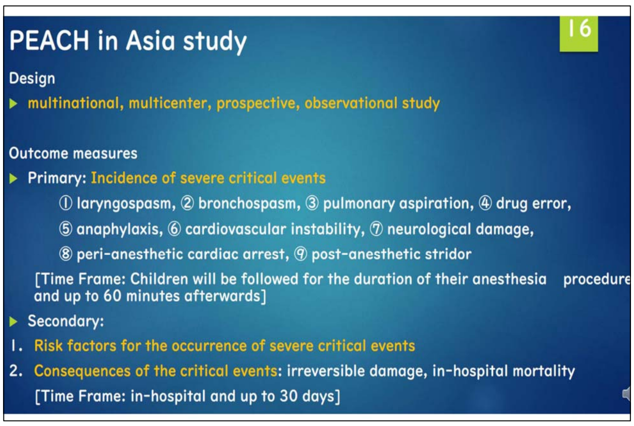

Pediatric Anesthesia fellowship program at Bosnia and Herzegovina
GERMANY
CZECH REPUBLIC
SLOVAKIA
SWITZERLAND
AUSTRIA
HUNGARY
SLOVENIA
ROMANIA
CROATIA
BOSNIA AND HERZEGOVINA
SERBIA
SARAJEVO
ITALY
KOSOVO
BULGARIA
MONTENEGRO
ADRIATIC SEA
MACEDONIA
ALBANIA
TYRRHENIAN SEA
© Encyclopædia Britannica


Anesthesia workforce data
Capital : Saraevo
Population : 3.8M
Life expectancy: 77y
<5y mortality rate: 5.86
PAP Density: 6.04
Population: 3,810,000
Physicians: 6,224
Physician anaesthesia providers: 230
Surgeons: 275
Nurse anaesthesia providers: 0
Other anaesthesia providers: 0
No. of physician providers that have an anaesthetic qualification: 195
Minimum duration of training (years) for physician anaesthesia providers: 5
Typical duration of training (years) for nurse anaesthesia providers: 0
Typical duration of training (years) for non physician / non-nurse anaesthesia providers: 0

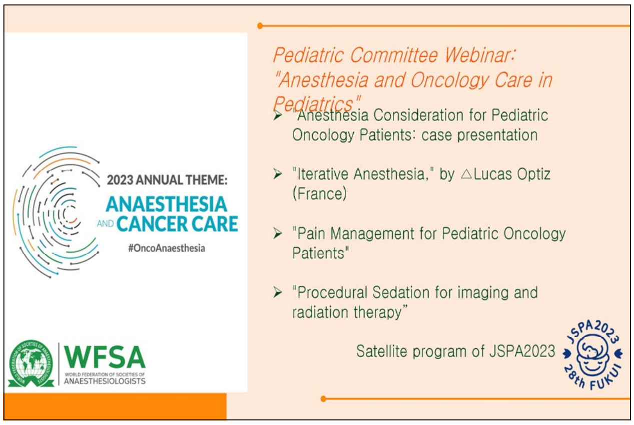
Norifumi Kuratani: Universal Coverage of Safe Pediatric Anesthesia all over the World: WFSA pediatric Anesthesia Committee








monthly ASPA FLEX webinar series, supported by WFSA committee project funding
PAEDIATRIC SEDATION
8th ASPA FLEX
Paediatric Perioperative Fluid Therapy
Learning airway through simulation

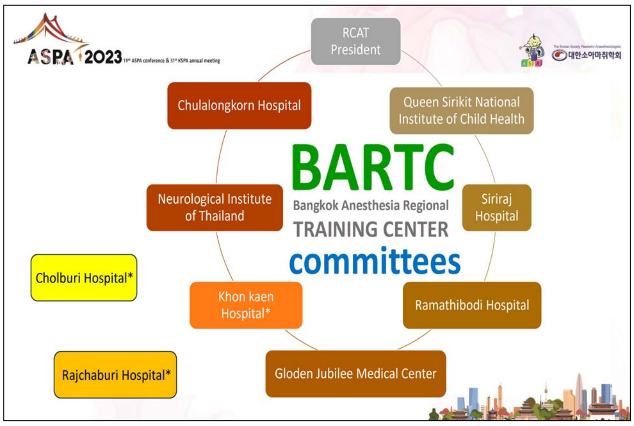

Pediatric Committee Webinar:
"Anesthesia and Oncology Care in Pediatrics"
2023 ANNUAL THEME:
ANAESTHESIA AND CANCER CARE
#OncoAnaesthesia
WFSA
WORLD FEDERATION OF SOCIETIES OF ANAESTHESIOLOGISTS
"Anesthesia Consideration for Pediatric Oncology Patients: case presentation
"Iterative Anesthesia," by △Lucas Optiz (France)
"Pain Management for Pediatric Oncology Patients"
"Procedural Sedation for imaging and radiation therapy"
Satellite program of JSPA2023
JSPA2023
28th FUKUI

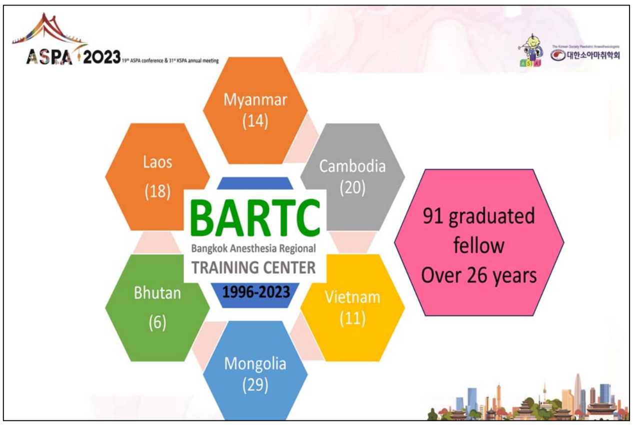

Conclusions
Unmet need
is common for safe pediatric anesthesia
Education
is key to change
Work together
to implement safe pediatric anesthesia all over the world
SAFE
Safer Anaesthesia From Education
WFSA
WORLD FEDERATION OF SOCIETIES OF ANAESTHESIOLOGISTS

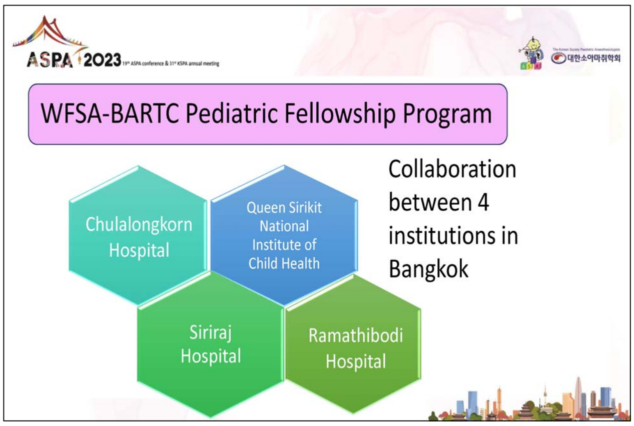
Activities and Accomplishments of the WFSA BARTC Pediatric Fellowship Program

Patcharee Sriswasdi

Department of Anesthesiology, Critical Care and Pain Medicine, Boston Children's Hospital, USA







WFSA-BARTC Pediatric Fellowship Program

Applicant requirement

- He/she works in a Government hospital and will return to this institution work after the training. (with letter recommendation from the Head of Department where he/she works)
- Recommendation from the Society of Anesthesia in his/her country.
- Work as an anesthesiologist for at least 3 years

WFSA-BARTC Pediatric Fellowship Program

Applicant requirement

- The number of pediatric cases in the institute that he/she works per year
- List of the surgical services for pediatric patients in your institution.
- The total number of pediatric cases that he/she has anesthetized per year in the past.

12 months Rotation

Institute	Month	Rotation	Topic discussion
Siriraj	15-31 January 2021	General surgery	Premature babies, neonates and infants: basic science, physiology, pharmacology, monitoring, psychology
Siriraj	1-14 February 2021	Urology	URI, emergence delirium, airway obstruction, laryngospasm, laryngeal edema
Siriraj	15 February - 15 March 2021	Neuro-ENT	Anesthesia for neuro-surgery: craniotomy, myelomeningocele, spine surgery
Chula	16 March - 15 April 2021	Gen-Uro-Thoracic	Upper and lower abdominal, groin, perineal and anorectal surgery, endoscopic surgery, thoracotomy
Chula	16 April 2021	Outside OR	Anesthesia for eye surgery: retinopathy of prematurity, strabismus & muscle correction
Chula	1-31 May 2021	Plastic/EENT	Anesthesia for maxillofacial surgery: craniofacial reconstruction, cleft lip/palate surgery
Rama	1-30 June 2021	Gen-Uro	Common congenital anomalies: Down syndrome
Rama	1-15 July 2021	Outside OR	Anesthesia for outside OR procedure: CT, MRI, bone scan, cath lab, endoscopy
Rama	16 July -15 August 2021	Plastic/EENT/Uro	Anesthesia for ENT: bronchoscopy, airway surgery, adenotonsillectomy, tympanoplasty, morbid obesity
Queen Sirikit	16 August -15 September 2021	Ortho/EENT	Anesthesia for orthopedics: scoliosis, limb deformity correction
Queen Sirikit	16 September-15 October 2021	Gen-Uro	Hypothermia , malignant hyperthermia, muscular dystrophy, Postoperative pain management (multimodal analgesia)
Queen Sirikit	16-31 October 2021	Neuro/Outside OR	Massive bleeding, glucose, fluid, electrolyte management
Siriraj	1- 15 November 2021	GEN	Examination
	16 November 2021 - 10 January 2022		**Elective in 4 institutes**
	11-14 January 2022		**Final Presentation on Graduation Day**

Minimal case requirement 100 cases

Age group	Cases	ETT	SI	CU	RA	QS
• NEONATE	10	15	5	5	5	5
• INFANT	40					
• Age >1- 6 year	30	10	3	3	3	3
• Age > 6 year	20					
Type of patients						
• In-patient	70					
• Ambulatory patient	15					
• Anesthesia for outside OR	15					
Type of surgery						
• Anesthesia for Gen-Uro surgery	30	All				
• Anesthesia for Neuro	5	Si				
• Anesthesia for EYE-ENT	15	All				
• Anesth. for Plastic & maxillofacial	10	Cu Ra				
• Anesthesia for orthopedics	5	Qs				
• Anesthesia for outside OR	15	Cu Ra				

Procedures	Cases	SI	CU	RA	QS
• Peripheral IV access	10	3	3	3	3
• Supraglottic airway device	10	3	3	3	3
• Undermask (General anesthesia)	10	3	3	3	3
• Setting mechanical ventilator	5	2	2	2	2
• Arterial line insertion	4	1	1	1	1
• Central line insertion	4	1	1	1	1
• Caudal block/ Epidural block/ Neuraxial block	5	2	1	1	2
• Peripheral nerve blockade/Penile/ Ilioinguinal/Iliohypogastric block	5	1	2	2	1
• Acute pain	10	3	3	3	3
• Management of difficult airway	Work shop				
• PALS					
• Postoperative care in ICU	8	2	2	2	2

WFSA-BARTC Pediatric Fellowship Program

- Started in January 2021: 1 Fellow from Nepal
- Stopped in January 2022 due to COVID
- July 2022- June 2023: 1 Fellow from Bhutan (Funding from Bhutan government)
- Restart in January 2023: 1 Fellow from Mongolia



Our current fellow

- Our goal is to promote safe anesthesia for patients in developing countries in Asia.

Our first graduated fellow

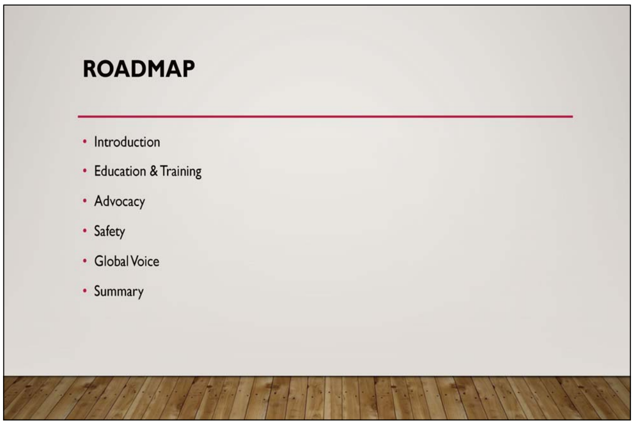
First trained pediatric anesthesiologist in Nepal

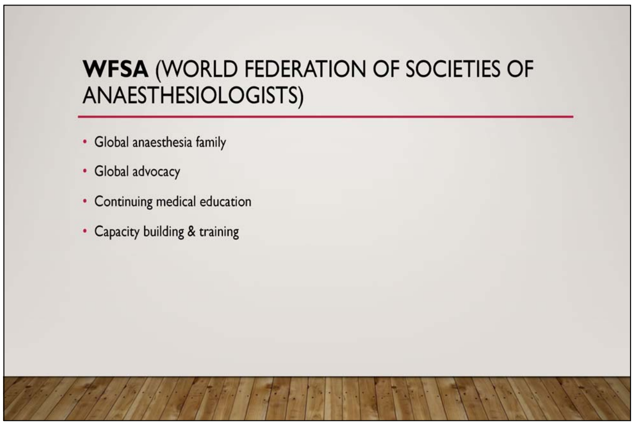


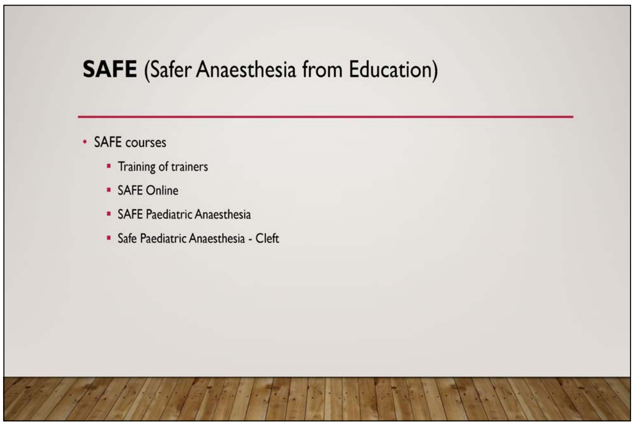
Improving Patient Safety Through the WFSA

Erlinda C. Oracion

WFSA Safety & Quality Of Practice Committee, Philippines







SAFE (Safer Anaesthesia from Education)

- VAST (Vital Anaesthesia Simulation Training)
  - Essential practices to perioperative teams
  - On-line learning + hands-on simulations
  - Resuscitation for OB, Pedia, Trauma
  - Pre- and post-operative care

"The WFSA is unique in terms of its positioning, global membership and reach. There are no other organizations in the perioperative space quite like it, and our role…. on the international stage is a powerful one."

Kristine Stave, Chief Executive Officer

ADVOCACY

- Engagement with decision makers
- Advance availability, safety, and quality of anaesthesia and perioperative services worldwide
- Amplify the voices of anaesthesiologists at the local, regional, and international levels
- Relationships
  - WHO (World Health Organization)
  - UN ECOSOC (United Nations Economic and Social Council)

"A concern of the WFSA in the early 1960's was anaesthesia workforce capacity building at the international level, in line with its objective of 'providing better anaesthesia for all the peoples of the world.'
In retrospect, it was the beginning of global anaesthesia, meaning that before globalization became a thing, there was a WFSA worldwide concept of anaesthesia."

Dr. Bisola Onajin-Obembe, President of G4 Alliance's Permanent Council
2022 WFSA Board Member

GUIDING PILLARS

1. UNITY
2. ACCESS
3. SAFETY

SAFETY

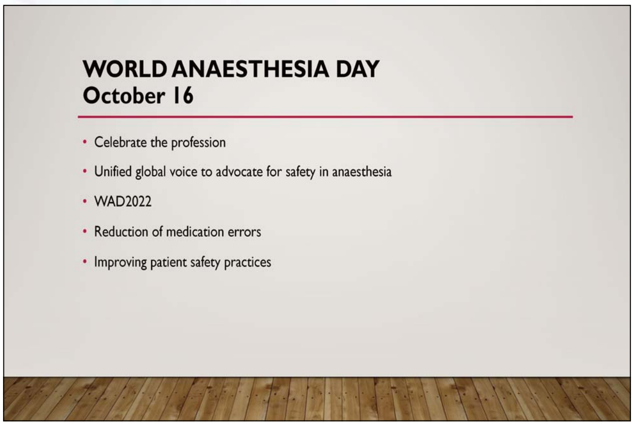
- WHO-WFSA International Standards for a Safe Practice of Anesthesia
- Minimum Capnometer Specifications 2021
- Consensus Statement on Environmentally– Sustainable Anaesthesia

SAFETY & QUALITY OF PRACTICE COMMITTEE

- To promote the highest standards of safety and quality in anaesthesiology internationally
- Seek new methods to implement safe practices throughout the world
- Provide the necessary educational and human resources needed in the provision of access to safe anesthesia for essential surgery
- Deliver safe anesthesia care as a basic human right
- Collaborate with other WFSA committees incorporating patient safety and quality improvement in their plans and activities

WORLD PATIENT SAFETY DAY September 17

- Advocate for improved global patient safety standards and practices
- 2022 – Medication Without Harm


WORLD ANAESTHESIA DAY
October 16
Celebrate the profession
Unified global voice to advocate for safety in anaesthesia
WAD2022
Reduction of medication errors
Improving patient safety practices


SUMMARY
WFSA's strength – Member Societies
Expertise and knowledge drawn together
Diversity and global reach of members
Unique organization
Promoting safe anesthesia and perioperative care on a global scale
WFSA Programmes

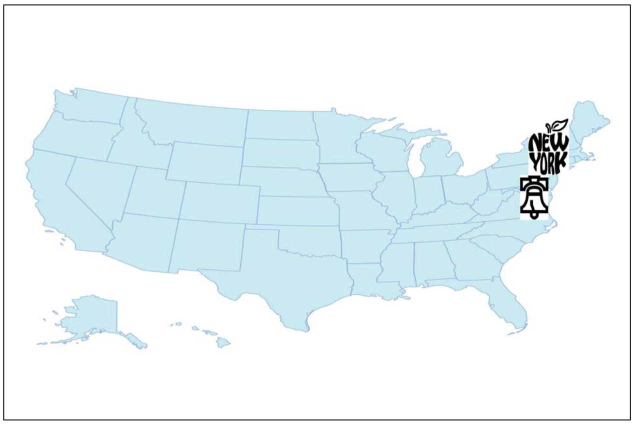
Luncheon Symposium

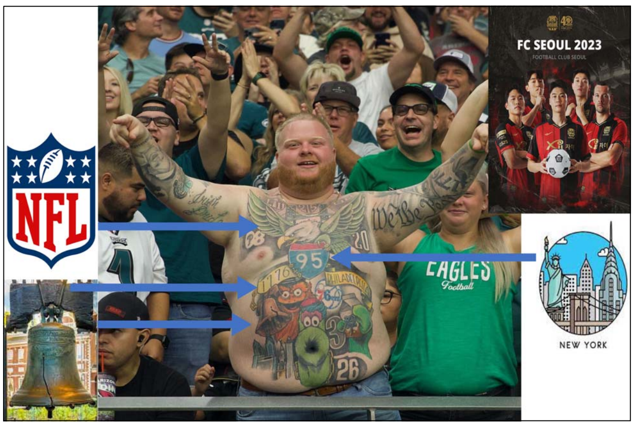
Chair(s): Dong Woo Han (Korea)

EEG Guided Anesthesia in Young Children (Virtual)

Ian Yuan

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





<u>CHOP Childrens Hospital of PHiladelphia</u>

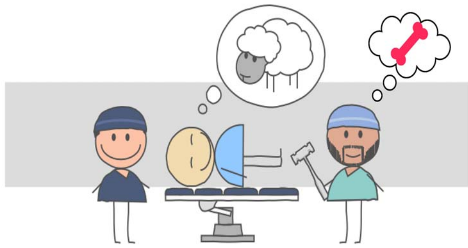
33k cases / year

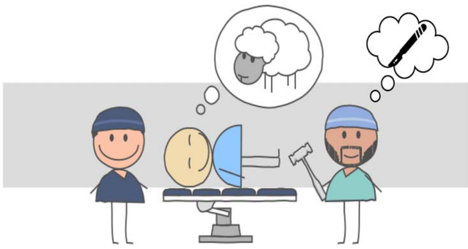
75 Pediatric Anesthesiologist (9 Cardiac)

30 Nurse Anesthetists

11 Fellows

10 Residents





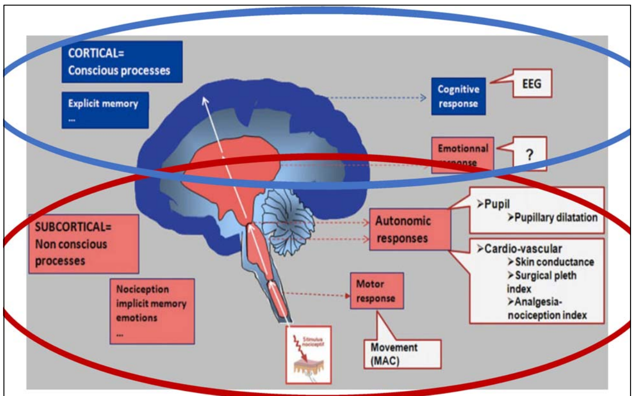
A. Increase the Sevoflurane

B. Bolus Propofol

C. Muscle relaxant

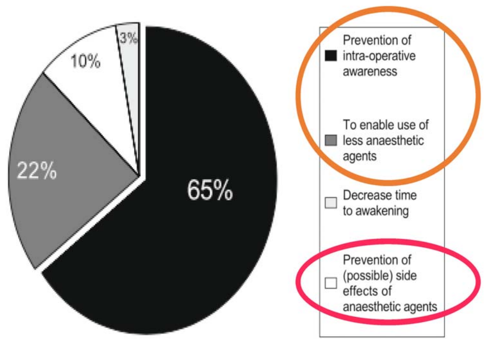
D. EEG

≠ Unconscious



Constant I, Sabourdin N. Pediatric anesthesia. 2015

Chan MT, A&A 2020



N = 140

Cheung YM. BMC Anesthesiology 2018

Young children sensitive to effects of excess anesthesia (hypotension)

Proprietary EEG indices (eg. BIS, PSI) not reliable

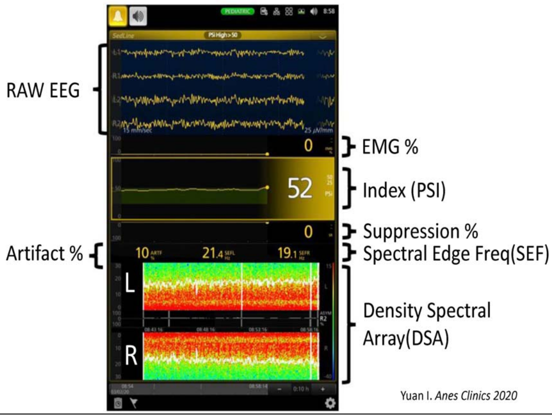
How to use EEG to guide anesthesia in young children

EEG guided anesthetic in young children

EEG waveforms and processed EEG parameters

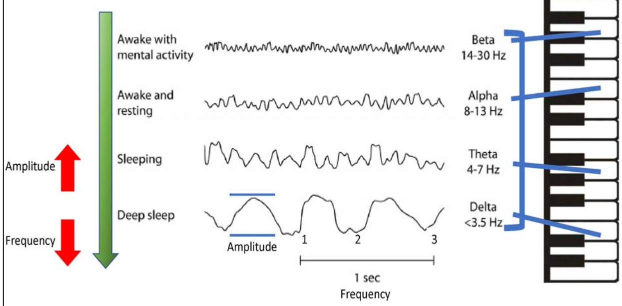
EEG changes with anesthetic and age

2 cases studies



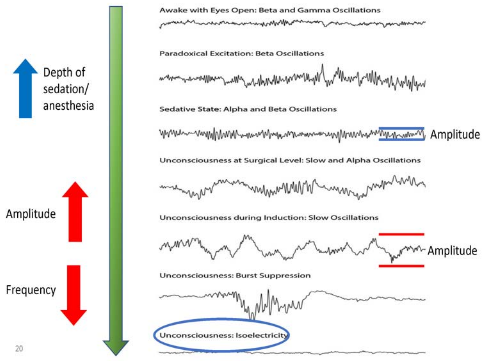
18 Yuan I. *Anes Clinics 2020*

EEG changes with sleep



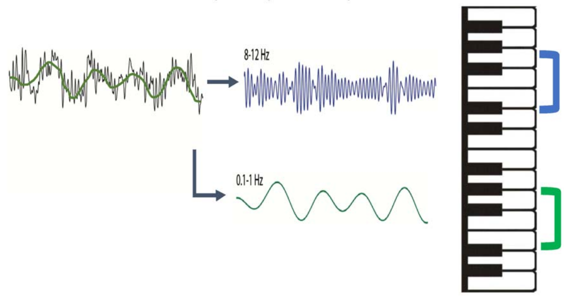
19 Abhang PA. Current Journal of Applied Science & Technology. 2015

EEG changes with Anesthesia

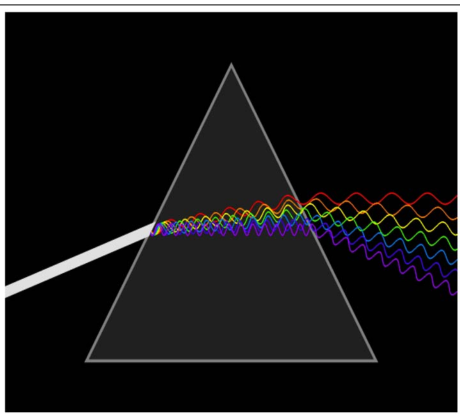


20 Purdon PL. *Anesthesiology* 2015

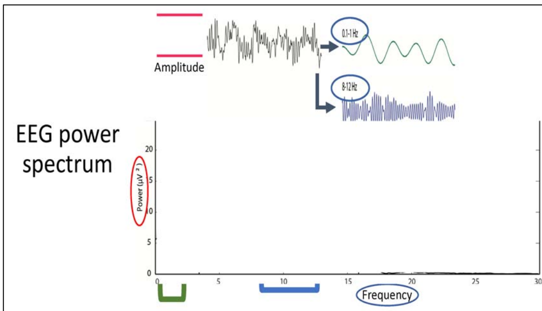
EEG frequency decomposition



21 Purdon et al. Anesthesiology 2015



22

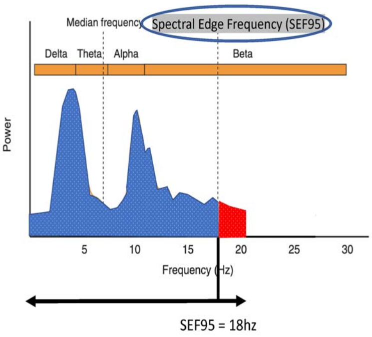


0.1-1 Hz 8-12 Hz

23 Purdon et al. Anesthesiology 2015

Spectral Edge Frequency (SEF)

Frequency where majority (95%) of power lies below it.

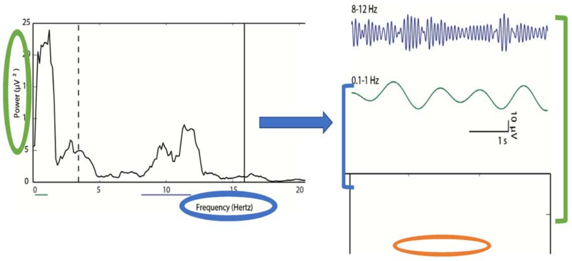


SEF targets (> 3-6mo)

Anesthetic state	*Clinical endpoint*	*SEF targets (hz)*
Conscious	Emergence	> 20
Light anesthesia	Sedation	15-20
Surgical anesthesia	Surgical maintenance	10-15
Deep anesthesia	Incision/Laryngoscopy	6-9
Burst suppression		< 5

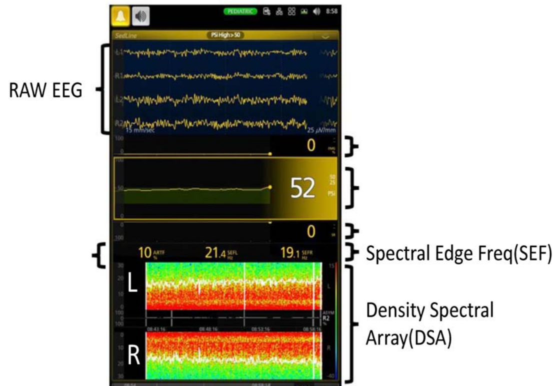
Yuan I. Anes. Clinics 2020

DSA (Density Spectral Array)



EEG changes over time.

Purdon et al. Anesthesiology 2015



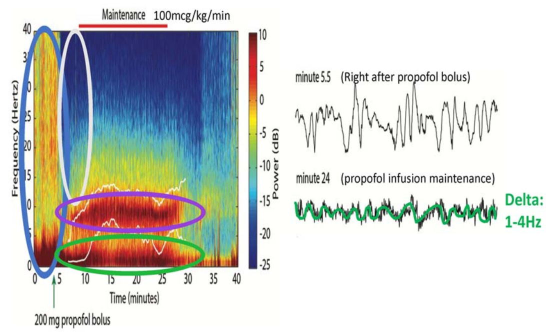
Yuan I. *Anes Clinics 2020*

EEG guided anesthetic in young children

EEG waveforms and processed EEG parameters

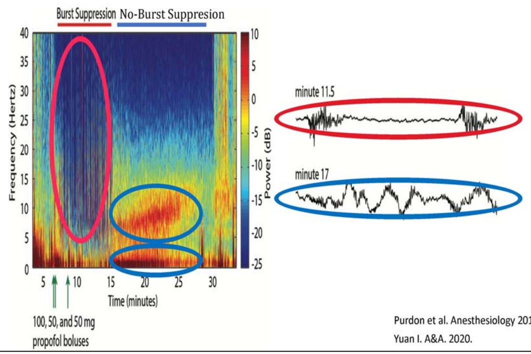
EEG changes with anesthetic and age

Propofol: Delta (1-4hz) & Alpha (8-13hz)



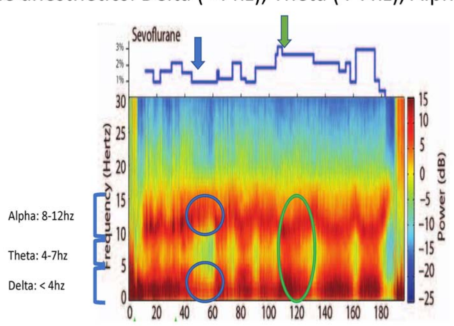
Purdon et al. Anesthesiology 2015

Too much propofol…

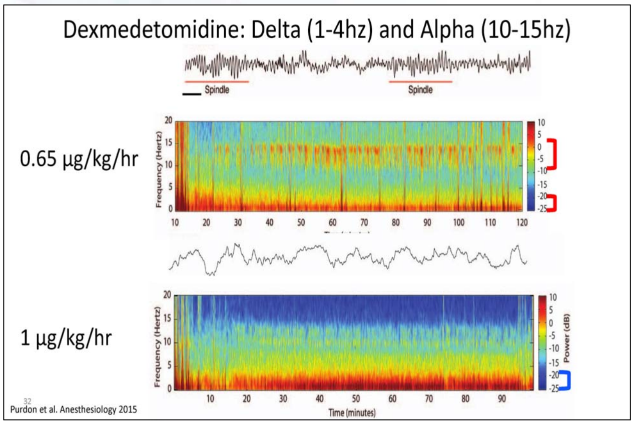


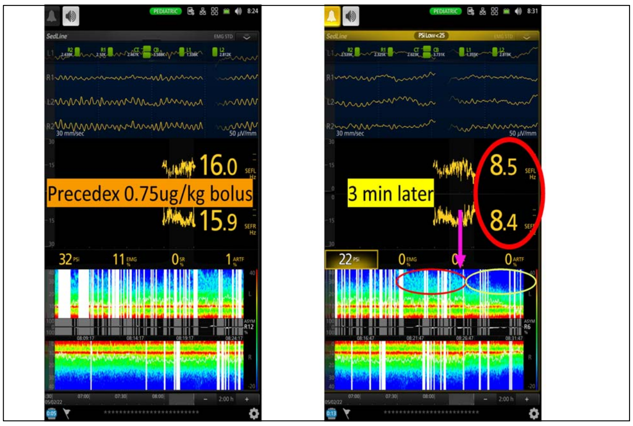
Purdon et al. Anesthesiology 2015
Yuan I. A&A. 2020.

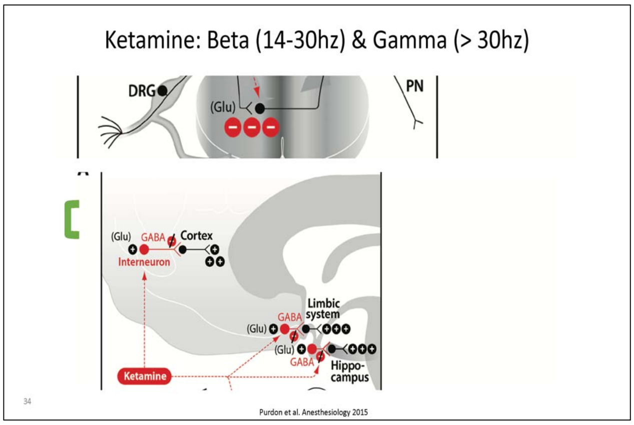
Volatile anesthetics: Delta (<4 hz), Theta (4-7hz), Alpha (8-13hz)

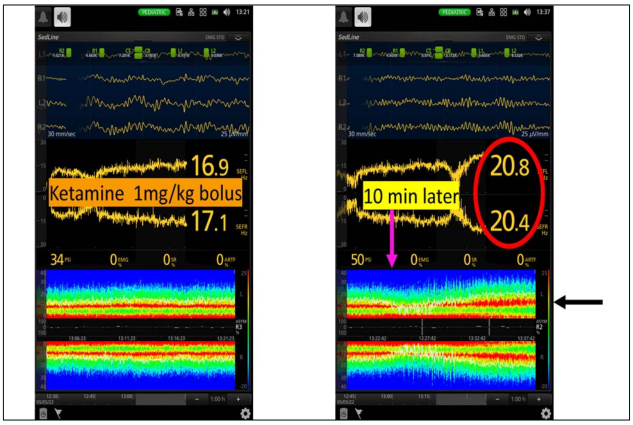


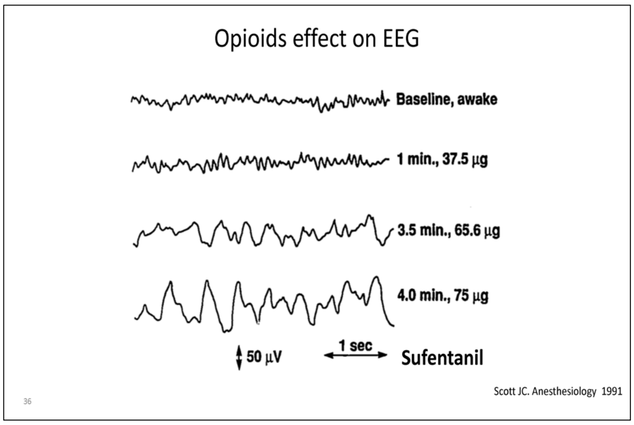
Purdon et al. Anesthesiology 2015

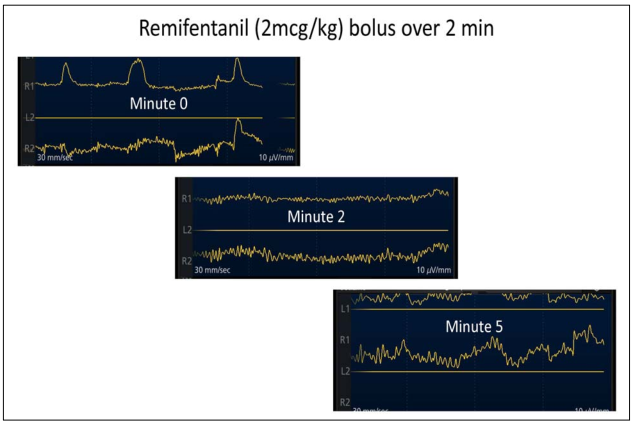

Dexmedetomidine: Delta (1-4hz) and Alpha (10-15hz)
Spindle
Spindle
0.65 μg/kg/hr
1 μg/kg/hr
Frequency (Hertz)
Power (dB)
Time (minutes)
Purdon et al. Anesthesiology 2015

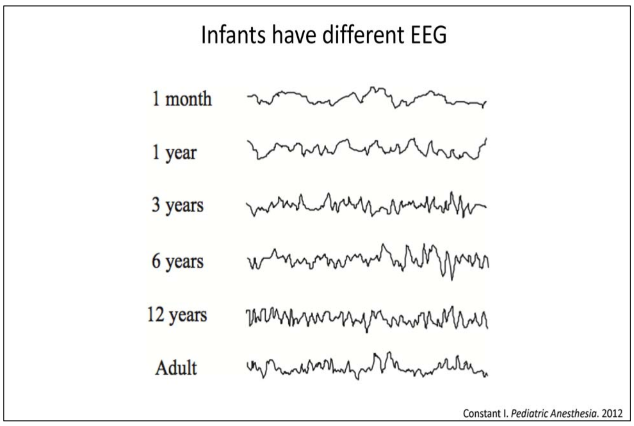

Precedex 0.75ug/kg bolus
16.0
15.9
3 min later
8.5
8.4

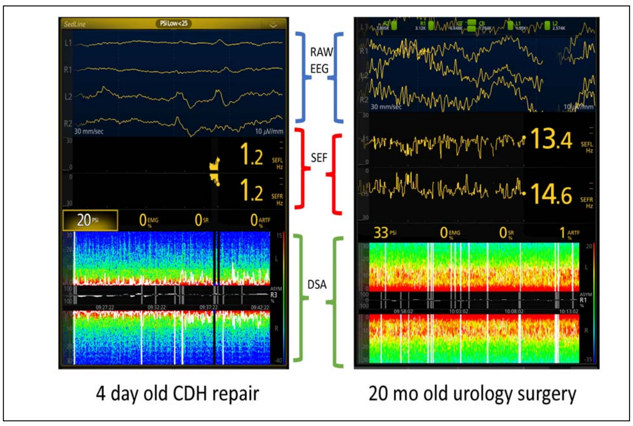

Ketamine: Beta (14-30hz) & Gamma (> 30hz)
DRG
PN
(Glu)
GABA
Cortex
Interneuron
Limbic system
Hippo-campus
Ketamine
Purdon et al. Anesthesiology 2015

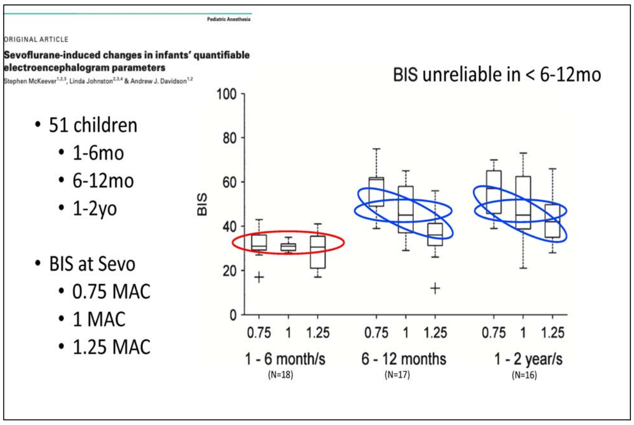

Ketamine 1mg/kg bolus
16.9
17.1
10 min later
20.8
20.4

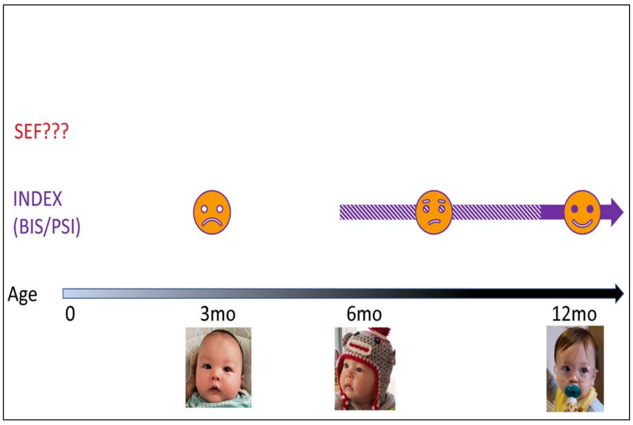

Opioids effect on EEG
Baseline, awake
1 min., 37.5 μg
3.5 min., 65.6 μg
4.0 min., 75 μg
50 μV
1 sec
Sufentanil
Scott JC. Anesthesiology 1991

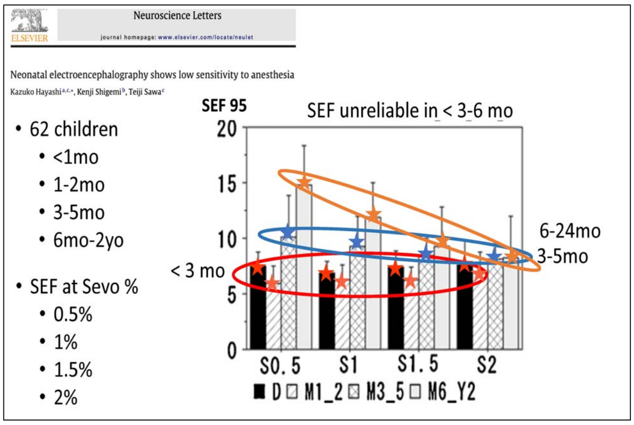

Remifentanil (2mcg/kg) bolus over 2 min
Minute 0
Minute 2
Minute 5

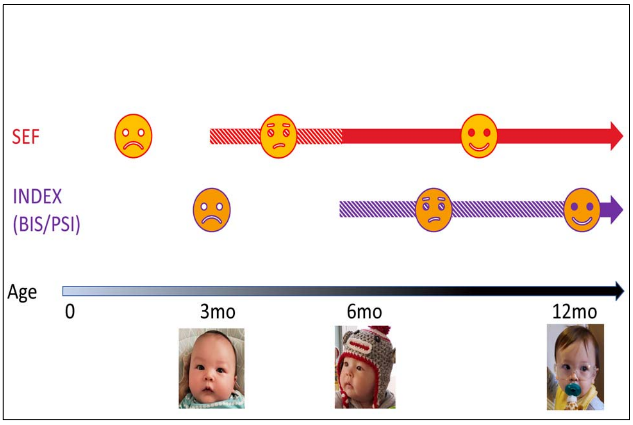

Infants have different EEG
1 month
1 year
3 years
6 years
12 years
Adult
Constant I. Pediatric Anesthesia. 2012

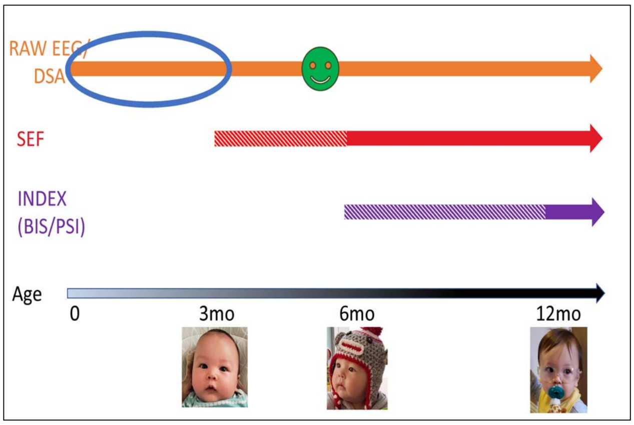

RAW EEG
SEF
DSA
1.2
1.2
13.4
14.6
4 day old CDH repair
20 mo old urology surgery

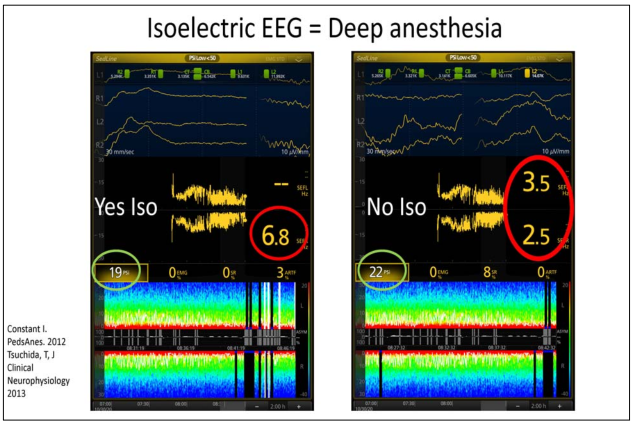












Isoelectric EEG bad?

Adults	Postop delirium, cognitive decline, and increased morbidity.
Children	32% children < 3y; 60% of infants < 3mo. Higher eSevo, propofol bolus, hypotension, and lower PedsQL.

Unnecessary in most situations.

46

Fritz, A&A 2016; Saczynski, NEJM 2012; Marcantonio, NEJM 2017
Seltzer, JTCVS 2016; Yuan, A&A 2020; Yuan, Anesthesiology 2022

EEG monitoring in children

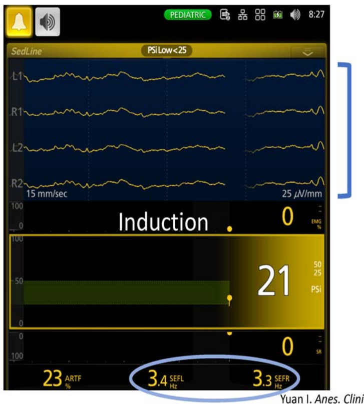
EEG waveforms and processed EEG parameters

EEG changes with anesthetic and age

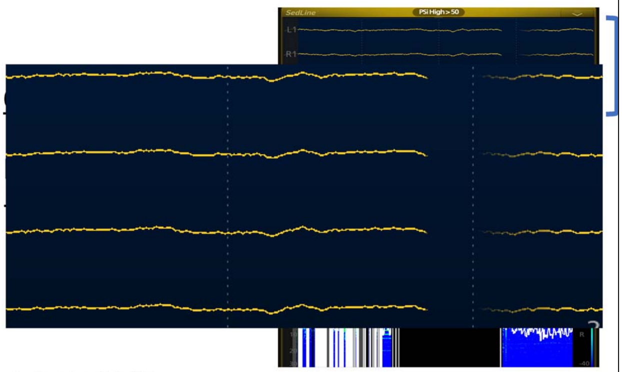
Cases studies

Case#1: 2mo old

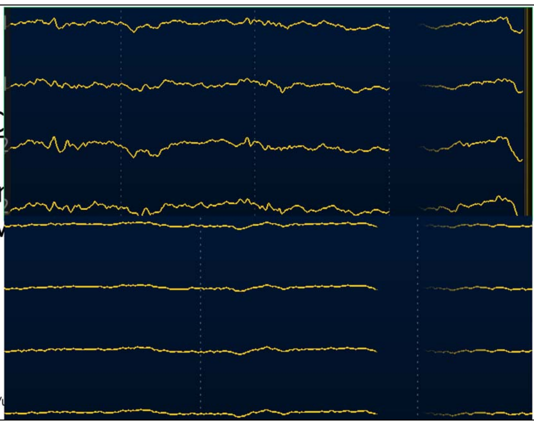
Sevo induction

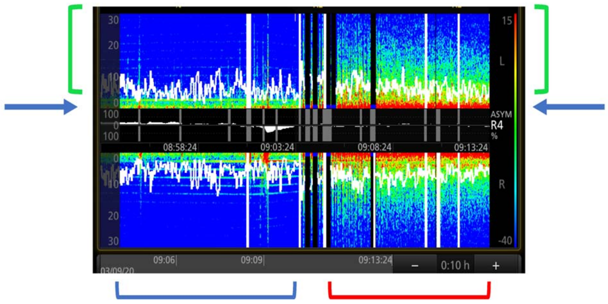


48 Yuan I. *Anes. Clinics.* 2020



49 Yuan I. *Anes. Clinics.* 2020





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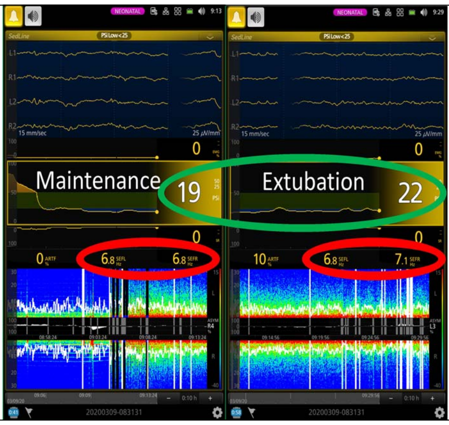
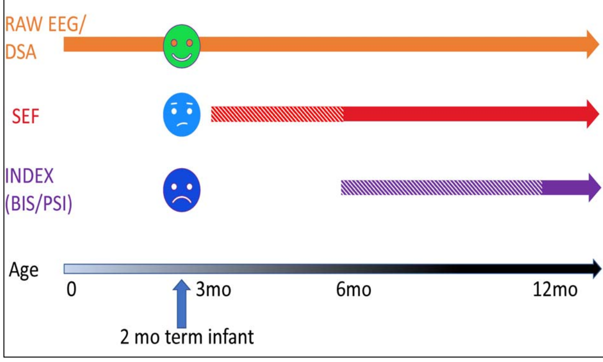
Case#1: 2mo

Extubation



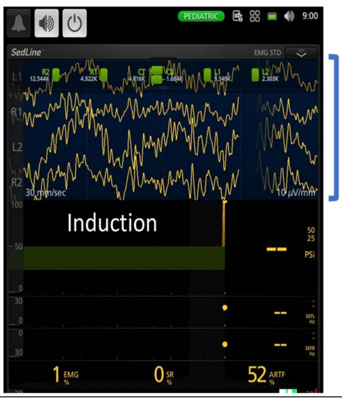
Yuan I. *Anes. Clinics.* 2020

Case 1 summary



Case#2: 10mo TIVA

TIVA with propofol and remifentanil



Yuan I. *Anes. Clinics.* 2020

Propofol dosing table

Age group	*0-1 mo*	*1-3 mo*	*3-6 mo*	*6-12 mo*	*1-3 yrs*	*3-12 yrs*
Propofol bolus (mg/kg)	3.5	3	3	3	3	2.5
Propofol 0-15 min (µg/kg/min)	183	200	200	208	217	250
Propofol 16-30 min	167	183	192	200	200	217
Propofol 30-60 min	150	167	175	183	192	183
Propofol 60-120 min	133	158	167	175	183	167
Propofol 120-180 min	117	150	158	167	175	150
Propofol 180-300 min	100	133	150	158	167	142

Yuan I. *Anes. Clinics.* 2020
Steur RJ. Ped Anes 2004
Morse J. Ped Anes 2019
Eleveld DJ. Br J Anaes 2018

Propofol Ce 3 µg/ml

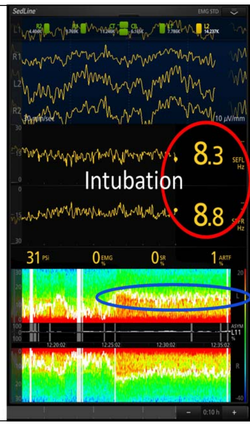
Recommended SEF ranges (> 3-6mo)

Clinical endpoint	*SEF range (hz)*
Emergence	> 20
Sedation	15-20
Surgical maintenance	10-15
Incision/Laryngoscopy	6-9
Burst Suppression	< 5

Yuan I. Anes. Clinics 2020

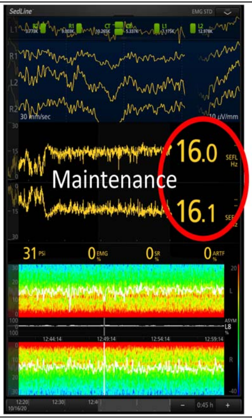
Case#2: 10mo TIVA

Intubation

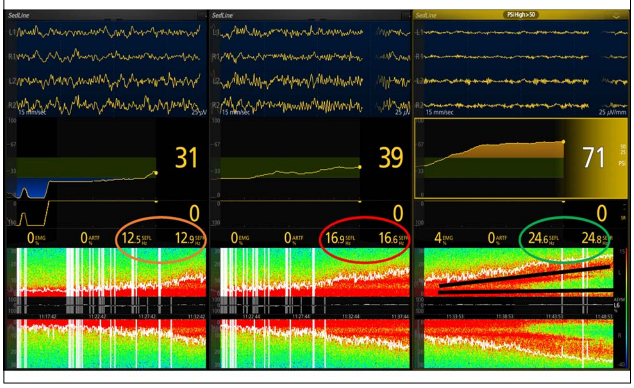


Case#2: 10mo TIVA

Incision ->
Maintenance

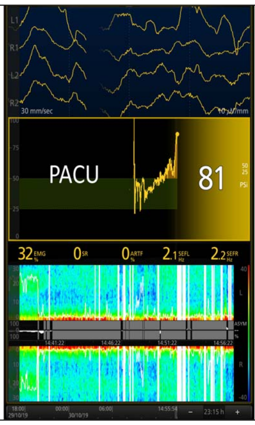


Maintenance **Emergence** **Extubation**

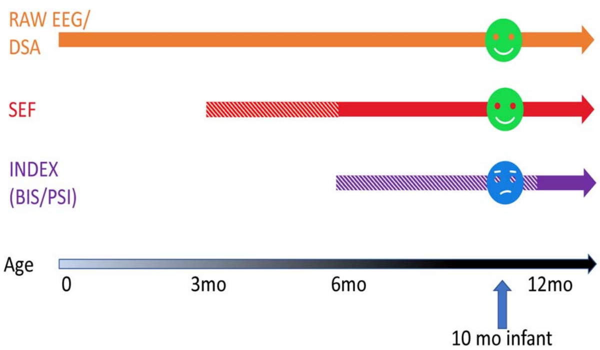


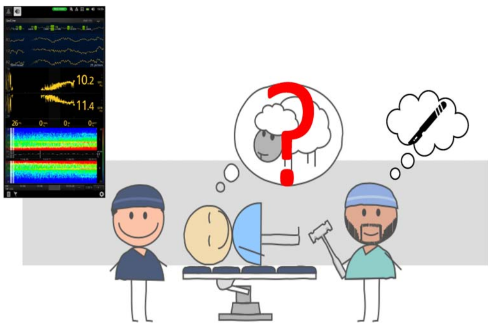
Case#2: 10mo TIVA

PACU



Case 2 summary





Session 3.

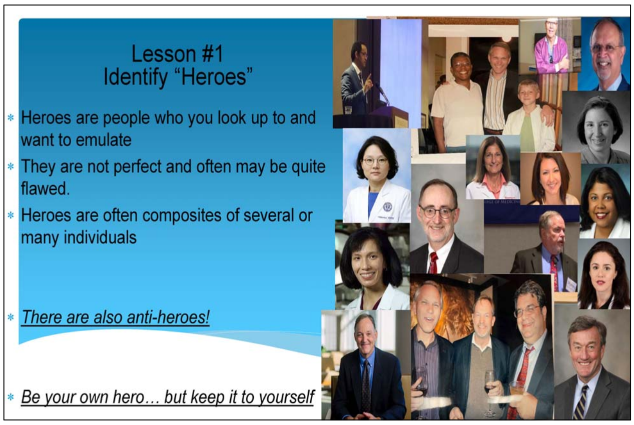
Preparing for the Future

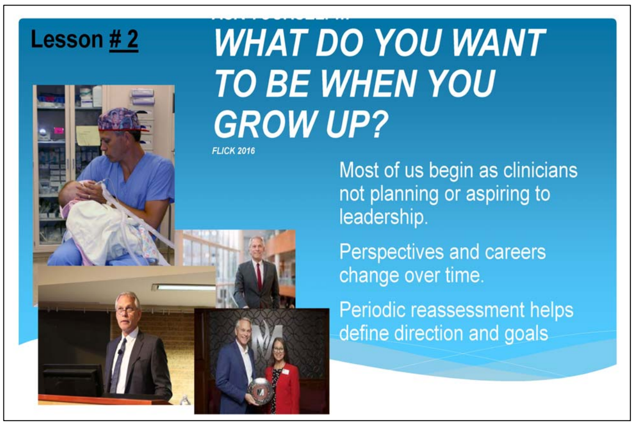
Chair(s): Choon Looi Bong (Singapore)
Jun Heum Yon (Korea)
Seong-Hyop Kim (Korea)

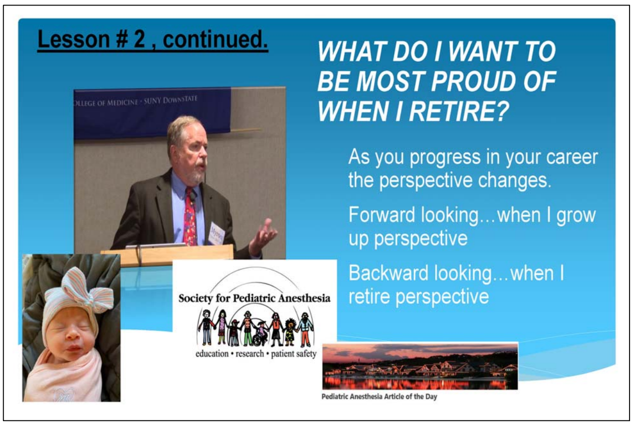
Thoughts on Leadership Professional Development and Career Success: Building the Future of Pediatric Anesthesiology Thoughts on Leadership

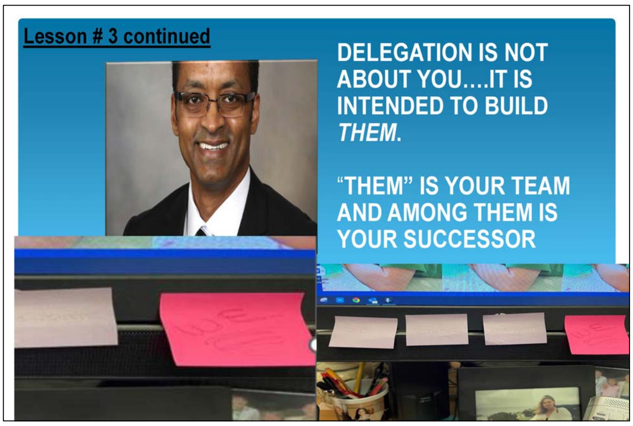
Randall Flick

Mayo Clinic Children's Center, USA

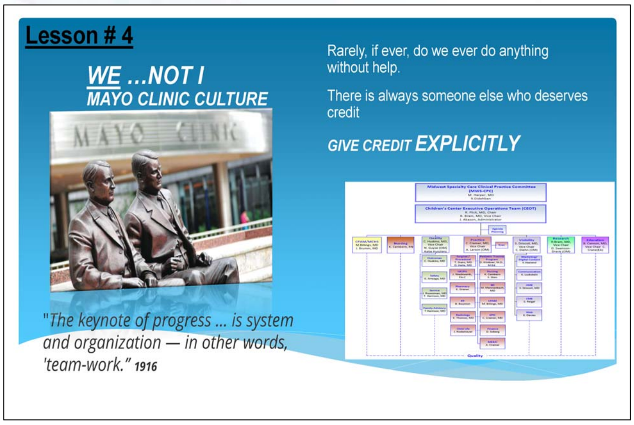


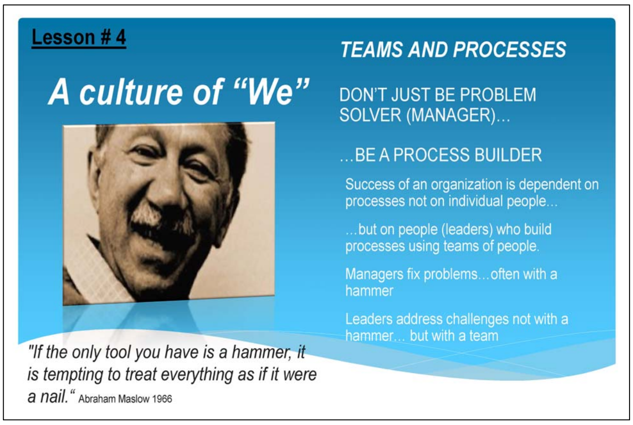


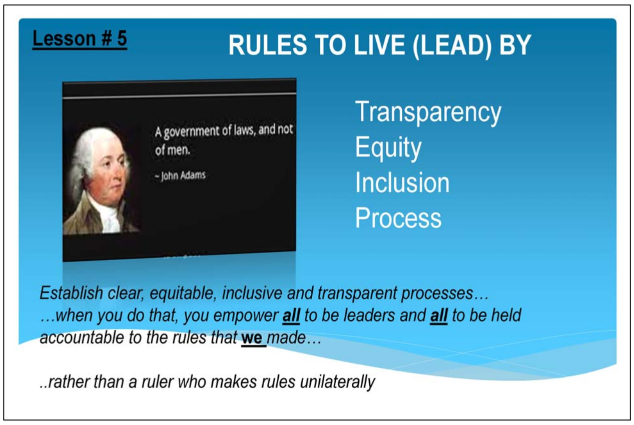


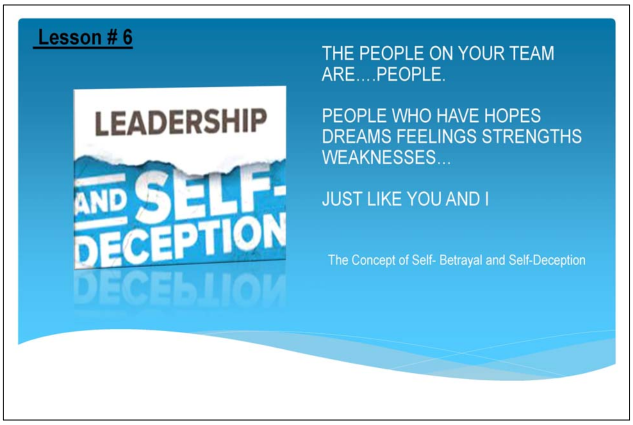


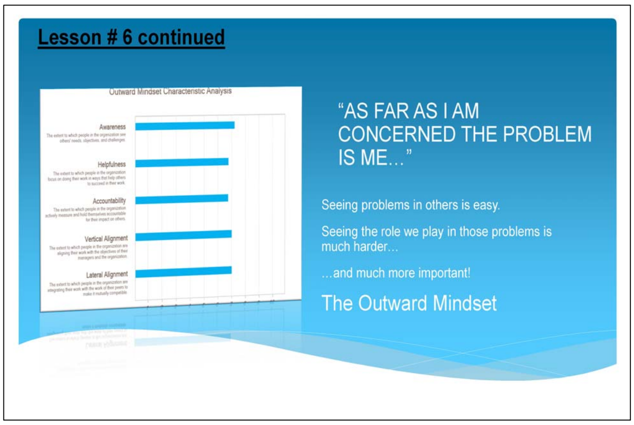
Randall Flick: Thoughts on Leadership Professional Development and Career Success: Building the Future of Pediatric Anesthesiology Thoughts on Leadership

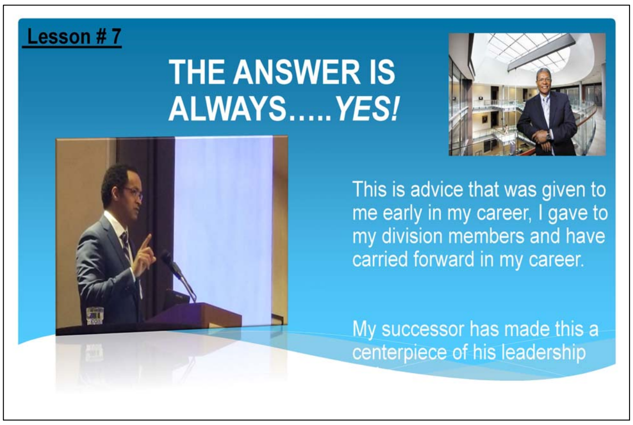


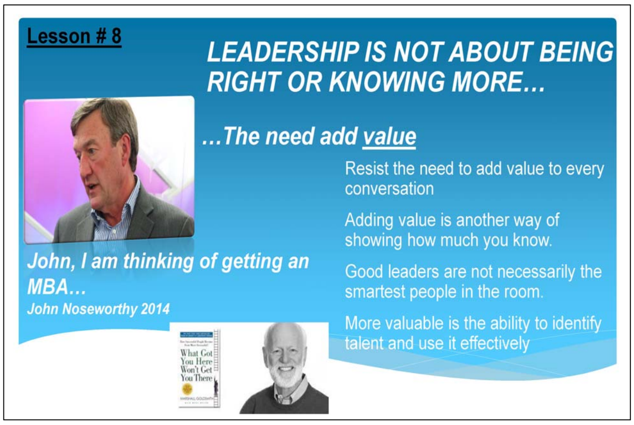


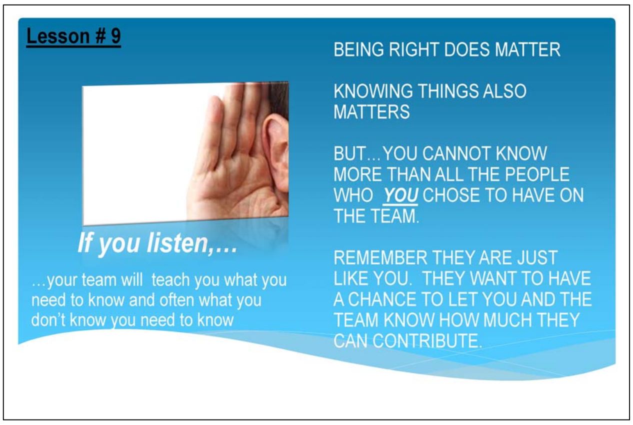


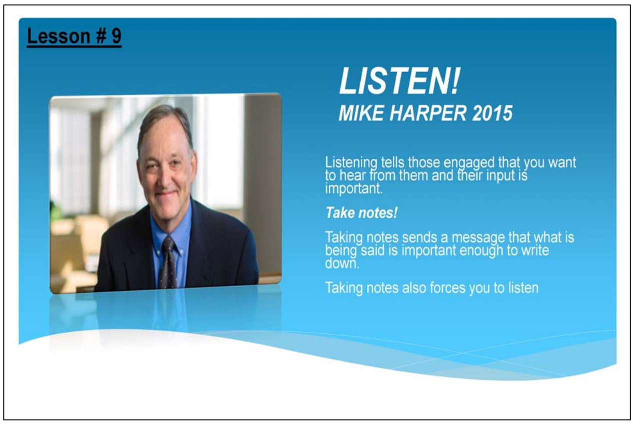


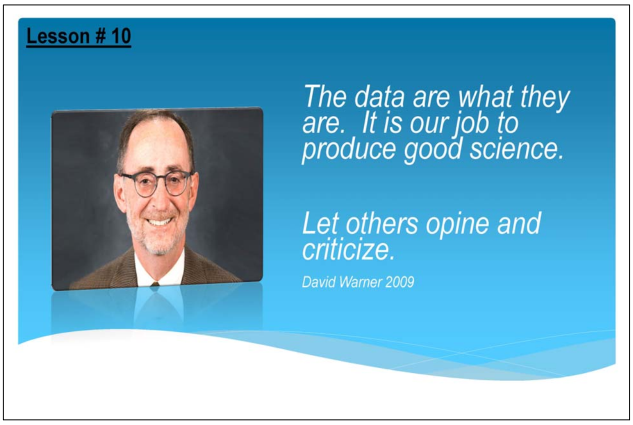


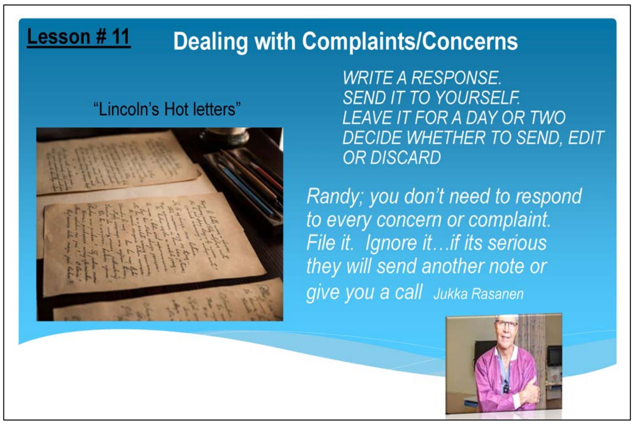


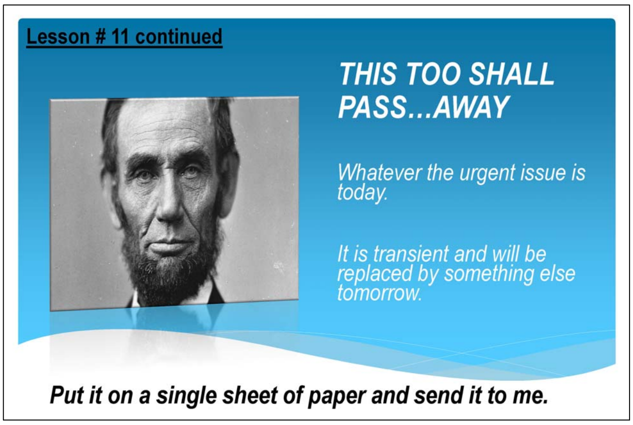


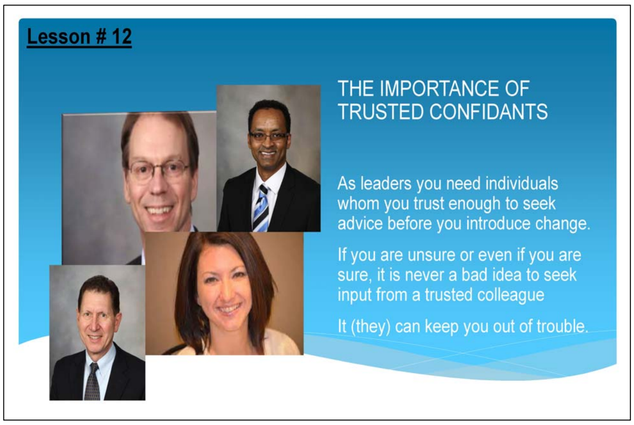


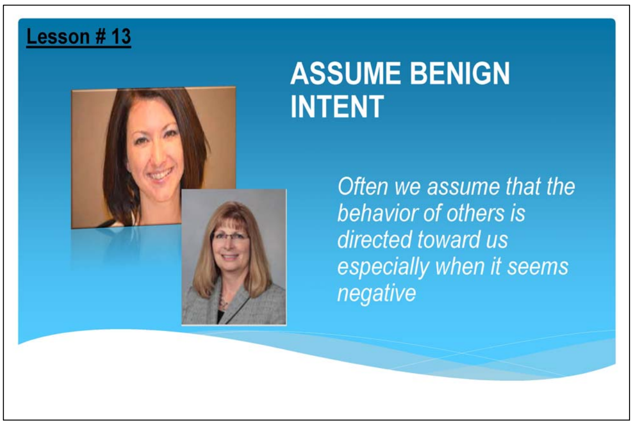

Lesson # 9
LISTEN!
MIKE HARPER 2015
Listening tells those engaged that you want to hear from them and their input is important.
Take notes!
Taking notes sends a message that what is being said is important enough to write down.
Taking notes also forces you to listen

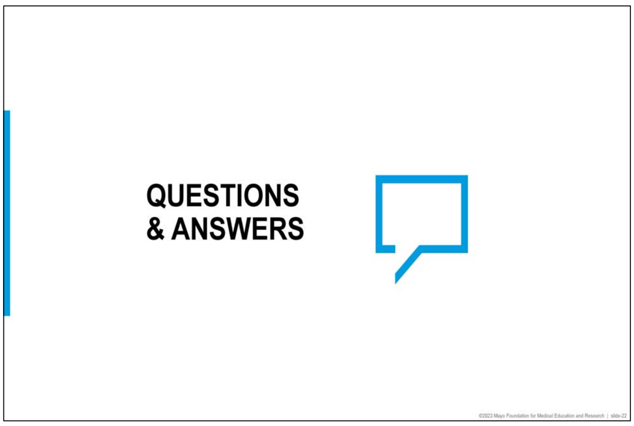

Lesson # 10
The data are what they are. It is our job to produce good science.
Let others opine and criticize.
David Warner 2009


Lesson # 11
Dealing with Complaints/Concerns
"Lincoln's Hot letters"
WRITE A RESPONSE.
SEND IT TO YOURSELF.
LEAVE IT FOR A DAY OR TWO
DECIDE WHETHER TO SEND, EDIT OR DISCARD
Randy; you don't need to respond to every concern or complaint. File it. Ignore it…if its serious they will send another note or give you a call
Jukka Rasanen


Lesson # 11 continued
THIS TOO SHALL PASS…AWAY
Whatever the urgent issue is today.
It is transient and will be replaced by something else tomorrow.
Put it on a single sheet of paper and send it to me.


Lesson # 12
THE IMPORTANCE OF TRUSTED CONFIDANTS
As leaders you need individuals whom you trust enough to seek advice before you introduce change.
If you are unsure or even if you are sure, it is never a bad idea to seek input from a trusted colleague
It (they) can keep you out of trouble.


Lesson # 13
ASSUME BENIGN INTENT
Often we assume that the behavior of others is directed toward us especially when it seems negative


QUESTIONS
& ANSWERS

How to Prepare for the Next Pandemic?

Nicola Disma

Research & Innovation Unit at Istituto Giannina Gaslini, Italy

Conflict of interests declaration

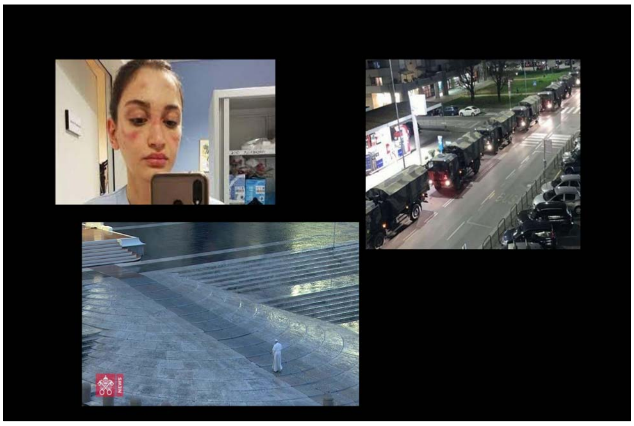
- No conflict of interests to declare

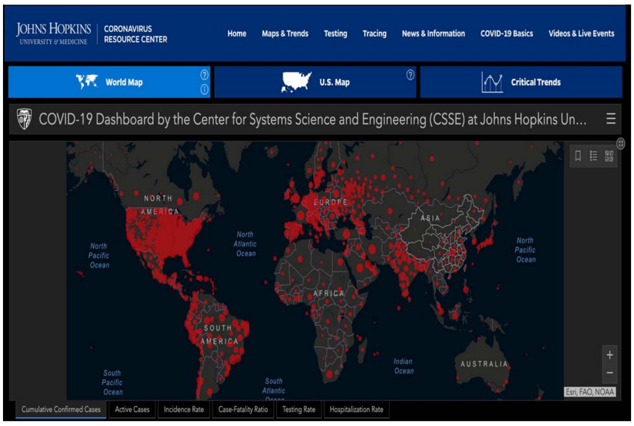
The background......

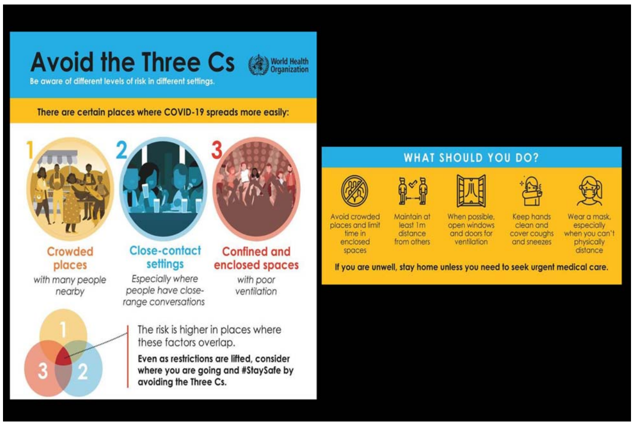
- January 30, 2020, two Chinese tourists where tested positive in Rome
- Feb 20, 2020, 16 cases in Lombardy
- March 11, 2020 The World Health Organization (WHO) declared the novel coronavirus (COVID-19) outbreak a global pandemic

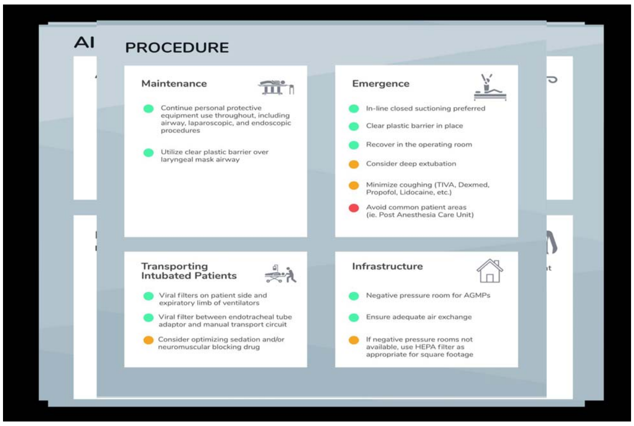
Then the *"whole world gone crazy»*

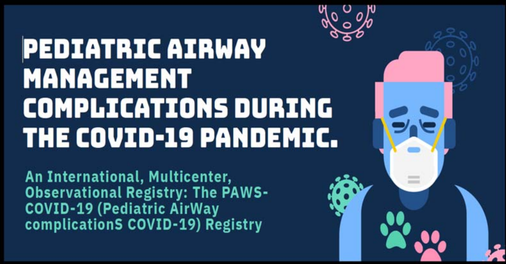
Karlsson J. SARS-CoV-2 airway reactivity in children: more of the same? Anaesthesia 2022

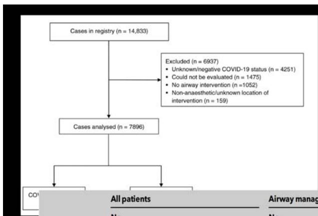












	All patients			Airway managed with tracheal tube			Airway managed with SAD		
	No COVID-19 n = 7567	COVID-19 n = 329	Odds ratio (95%CI)	No COVID-19 n = 4241	COVID-19 n = 232	Odds ratio (95%CI)	No COVID-19 n = 2432	COVID-19 n = 66	Odds ratio (95%CI)
Any hypoxaemia	214 (3%)	24 (7%)	2.70 (1.7–4.1)	162 (4%)	19 (8%)	2.25 (1.33–3.59)	40 (2%)	1 (2%)	0.92 (0.05–4.34)
Mild	121 (2%)	13 (4%)	2.53 (1.35–4.37)	87 (2%)	12 (5%)	2.60 (1.34–4.65)	28 (1%)	1 (2%)	1.32 (0.07–6.34)
Moderate	66 (1%)	9 (3%)	3.20 (1.47–6.14)	54 (1%)	5 (2%)	1.71 (0.59–3.92)	8 (<1%)	-	-
Severe	27 (<1%)	2 (1%)	1.71 (0.27–5.73)	21 (<1%)	2 (1%)	1.75 (0.28–6.00)	4 (<1%)	-	-

Tracheal extubation barrier used	418 (6%)	100 (30%)	<0.001
Plastic barrier over patient	360 (5%)	80 (24%)	
Plastic barrier under patient	2 (<1%)	-	
Transparent box	16 (<1%)	6 (1.8%)	
Transparent shield	131 (2%)	24 (7%)	
Other	25 (<1%)	7 (2%)	

Aftermaths (very personal)

- Stress test for NHSs
- Research & Innovation
- Long term consequences
- URTI

Aftermaths (very personal)

- **Stress test for NHSs**
- Research & Innovation
- Long term consequences
- URTI

Pandemics

- HIV/AIDS (2005-2012)
  - Death Toll: 36 million
- FLU PANDEMIC (1968)
  - Death Toll: 1 million
- ASIAN FLU (1956-1958)
  - Death Toll: 2 million
- Polio (1950s)
  - Death Toll: >100k
- SPANISH FLU (1918-1920)
  - Death Toll: 100 millions

Aftermaths (very personal)

- Stress test for NHSs
- **Research & Innovation**
- Long term consequences
- URTI

Dissemination of knowledge

- Advanced informatics
- Rapid publishing
- Social media
- Data repositories

Pubmed search 20 Sept 2022

- 296,187 published papers in 2020
  - ((wuhan[All Fields] AND ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields])) AND 2019/12[PDAT] : 2030[PDAT]) OR 2019-nCoV[All Fields] OR 2019nCoV[All Fields] OR COVID-19[All Fields] OR SARS-CoV-2[All Fields]
- 30,801 articles for children
  - ((wuhan[All Fields] AND ("coronavirus"[MeSH Terms] AND "coronavirus"[All Fields])) AND 2019/12[PDAT] : 2030[PDAT]) OR 2019-nCoV[All Fields] OR 2019nCoV[All Fields] OR COVID-19[All Fields] OR SARS-CoV-2[All Fields] AND children

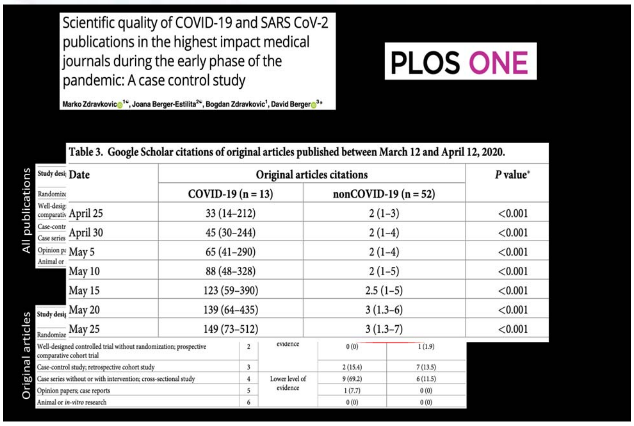
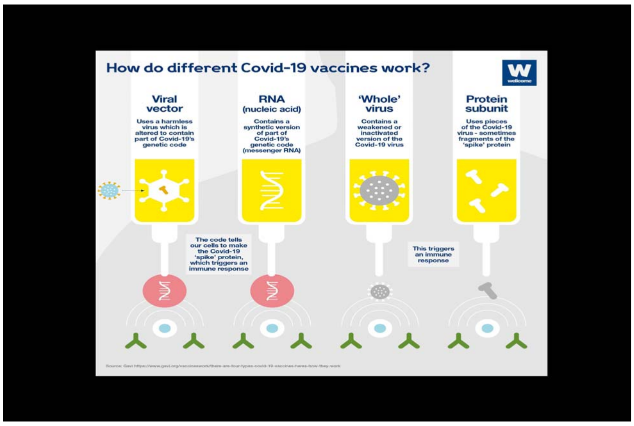
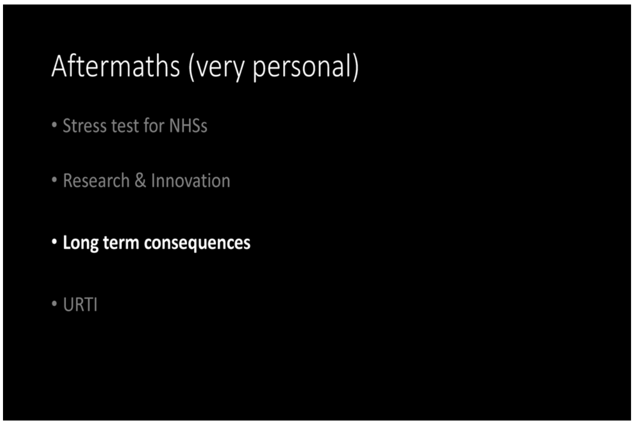
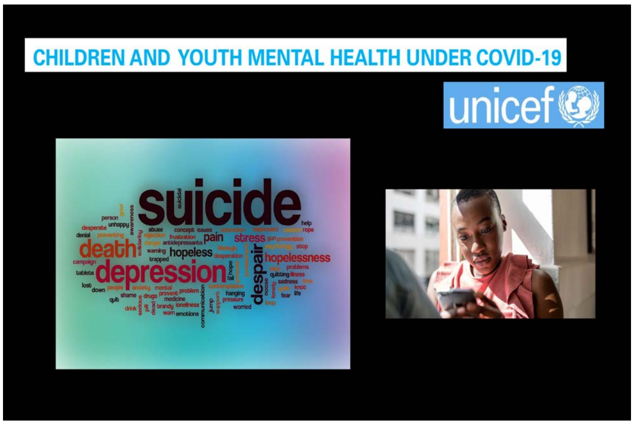


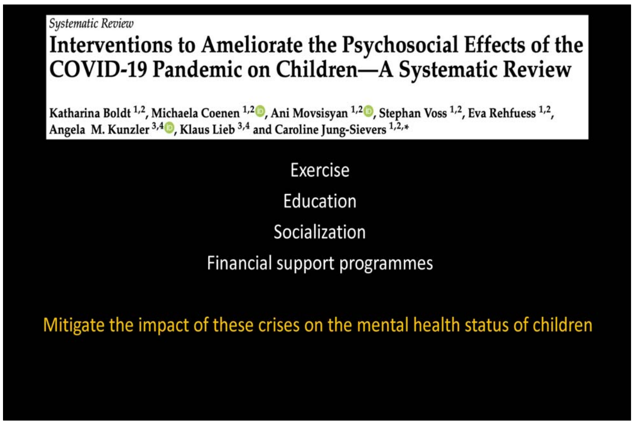
Table 3. Google Scholar citations of original articles published between March 12 and April 12, 2020.

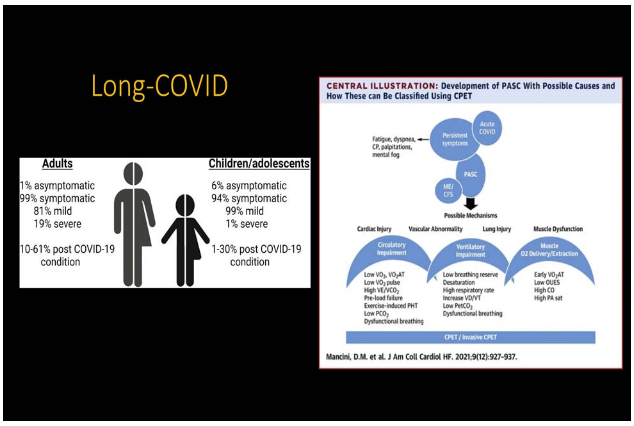
Date	Original articles citations		P value*
	COVID-19 (n = 13)	nonCOVID-19 (n = 52)	
April 25	33 (14–212)	2 (1–3)	<0.001
April 30	45 (30–244)	2 (1–4)	<0.001
May 5	65 (41–290)	2 (1–4)	<0.001
May 10	88 (48–328)	2 (1–5)	<0.001
May 15	123 (59–390)	2.5 (1–5)	<0.001
May 20	139 (64–435)	3 (1.3–6)	<0.001
May 25	149 (73–512)	3 (1.3–7)	<0.001

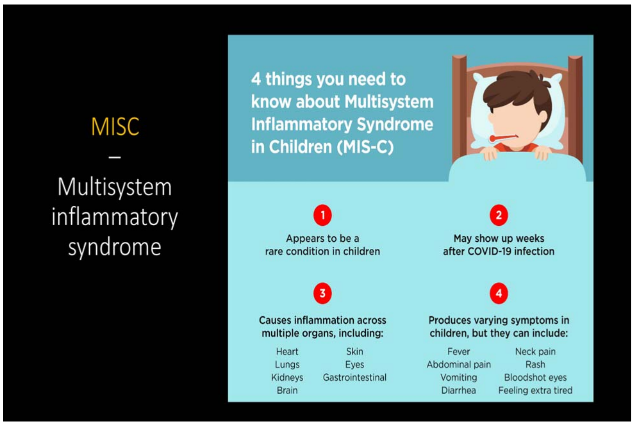










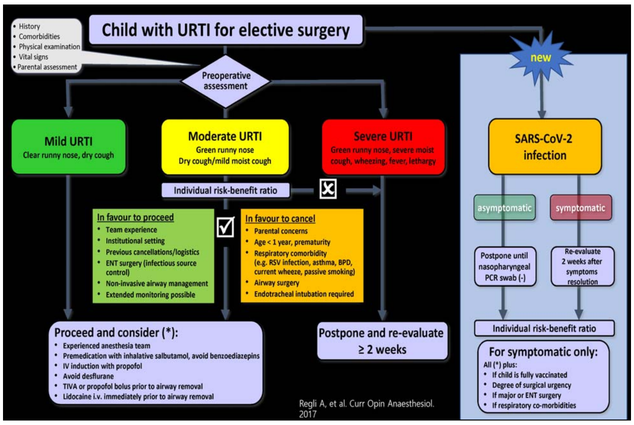


Aftermaths (very personal)

- Stress test for NHSs
- Research & Innovation
- Long term consequences
- **URTI**

Paediatric infectious disease – *"The perfect storm"*

- COVID-19 variants, RSV, influenza A and B, haemophilus influenzae, rhinovirus, and pneumococcal variants, etc….
- Precautionary measures like
  - rapid point of care testing
  - appropriate methods for securing the airways
  - techniques designed to limit the spread of disease



Reflections

1. What is the relevance of *paediatric anaesthesia network* during a rapidly evolving pandemic?
2. How and where *new devices and techniques* should be tested?
3. How to rapidly *implement clinical practice*, when scientific evidence is weak?
4. What is the role of paediatric anaesthesia services in redefining *hospital organization and patients' flow*?

``Has the whole world gone crazy?´´

``I can't be worried about that…. anymore. Life goes on, man!´´

Karlsson J. SARS-CoV-2 airway reactivity in children: more of the same? Anaesthesia 2022

Time to Obtain Epidemiologic Data on Pediatric Anesthesia in Asia Itself: Introduction of PEACH in Asia Study

Soichiro Obara

Tokyo Metropolitan Otsuka Hospital, Japan

Learning Objectives

1. Describe the rates of pediatric anesthesia related mortality and morbidity (serious adverse events) in developing and developed countries, although those definitions varies among studies
2. Review a number of large national or international epidemiological studies regarding the morbidity in children undergoing anesthesia and sedation which have been conducted or trialed in Europe, North America, Latin America, and Africa in recent years
3. Discuss the need for data describing the morbidity and mortality throughout Asia and the ongoing ASPA epidemiological research project, PEri Anesthetic morbidity in CHildren in Asia (PEACH in Asia) study

1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

Incidence of morbidity and mortality in pediatric anesthesia

- Pediatric anesthesia-related mortality
  - ↓ 0.01-0.05% in high-income countries
  - × 2-3 in developing countries
- Pediatric anesthesia-related severe adverse events
  - 2-8 % in developed countries

    the definitions of "severe adverse events" varies among studies

1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

Previous studies related to severe critical events in pediatric anesthesia in developed countries outside Asia

	Philadelphia, USA	Cincinnati, USA	Perth, Australia	Utrecht, Netherlands	Paris, France
Study design	Retrospective, case-control, Single center	Prospective, single center	Prospective, single center	Retrospective, single center	Prospective, single center
Study period	30 months (2010-2012)	6 years (2007-2012)	1 year (2007-2008)	6 years (2007-2013)	30 months (2000-2002)
Number of registered cases	55,070	19,059	9,297	35,190	24,165
Severe critical events [%]	0.4			3.4	7.9
Respiratory critical events [%]	0.26	2.8	15.0	1.6	4.1
Cardiac arrest [%]					0.033

1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

Previous studies related to severe critical events in pediatric anesthesia in Asia

	Pakistan	Singapore	Thailand	South Korea	Japan
Study design	Retrospective, single center	Retrospective, single center	Prospective, 20 centers	Retrospective, single center	Clinical audit, 739 centers
Study period	25 years (1992-2016)	11 years (2000-2010)	1 year (2003-2004)	6 years (2014-2019)	5 years (1999-2003)
Number of registered cases	48,828	75,331	25,098	53,541	342,840
Severe critical events [%]	0.08	3.34	1.88	0.55	
Respiratory critical events [%]	0.027	2.33		0.32	
Cardiac arrest [%]	0.026	0.015 (near cardiac arrest)	0.051	0.047	0.0511 – 0.103, depending on institution type

1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe

Walid Habre, Nicola Disma, Katalin Virag, Karin Becke, Tom G Hansen, Martin Jöhr, Brigitte Leva, Neil S Morton, Petronella M Vermeulen, Marzena Zielinska, Krisztina Boda, Francis Veyckemans, for the APRICOT Group of the European Society of Anaesthesiology Clinical Trial Network*

Lancet Respir Med 2017
Published Online March 28, 2017
http://dx.doi.org/10.1016/S2213-2600(17)30116-9

- Design: **a prospective, international, multicenter, observational study**
- Aims:
  1. To establish the incidence of severe critical events in children undergoing anesthesia
  2. To describe the differences in pediatric anesthesia practice
  3. To study the potential impact of this variability on the occurrence of severe critical events

     ① laryngospasm, ② bronchospasm, ③ pulmonary aspiration, ④ drug error, ⑤ anaphylaxis, ⑥ cardiovascular instability, ⑦ neurological damage, ⑧ peri-anesthetic cardiac arrest, ⑨ post-anesthetic stridor

1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe

Results:

- Recruitment period: 10 months (Apr 2014 – Jan 2015)
- No. of participating institutions: 261, across 33 European countries
- No. of anesthetics included: 31,127
- **Incidence of severe critical events: 5.2% (95%CI 5.0–5.5)**
- **Incidence of respiratory critical events: 3.1% (95%CI 2.9–3.3)**
- **The experience of the anesthesiologist in charge reduced respiratory and cardiovascular severe critical events**

1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

Morbidity and mortality after anaesthesia in early life: results of the European prospective multicentre observational study, neonate and children audit of anaesthesia practice in Europe (NECTARINE)

Nicola Disma[1,*], Francis Veyckemans[2], Katalin Virag[3], Tom G. Hansen[4,5], Karin Becke[6], Pierre Harlet[7], Laszlo Vutskits[8,9], Suellen M. Walker[10], Jurgen C. de Graaff[11], Marzena Zielinska[12], Dusica Simic[13], Thomas Engelhardt[14] and Walid Habre[8,9], for the NECTARINE Group of the European Society of Anaesthesiology Clinical Trial Network[†]

- Design: **a prospective, international, multicenter, observational study**
- Patients: Up to 60 weeks' postmenstrual age undergoing anesthesia for surgical or diagnostic procedures
- Aims:
  1. To to identify thresholds of pre-determined physiological variables that triggered a medical intervention
  2. To evaluate morbidities, mortality at 30 and 90 days, or both, and associations with critical events

1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

Morbidity and mortality after anaesthesia in early life: results of the European prospective multicentre observational study, neonate and children audit of anaesthesia practice in Europe (NECTARINE)

Results:

- Recruitment period: 11 months (Mar 2016 – Jan 2017)
- No. of participating institutions: 165, across 31 European countries
- No. of recruited neonates included: 5,609
- **Incidence of critical events: 35.2% of cases**
  - **mainly hypotension (>30% decrease in BP) or reduced oxygenation (SpO_2 <85%)**

1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

Systematic Review / Meta-analysis

Global mortality of children after perioperative cardiac arrest: A systematic review, meta-analysis, and meta-regression

Semagn Mekonnen Abate[a,*], Solomon Nega[b], Bivash Basu[a], Kidanemariam Tamrat[c]

[a] Department of Anesthesiology, College of Health Sciences and Medicine, Dilla University, Ethiopia
[b] Department of Internal Medicine, College of Health Sciences and Medicine, Dilla University, Ethiopia
[c] Department of Anesthesiology, College of Health Sciences and Medicine, Hawassa University, Ethiopia

Annals of Medicine and Surgery 74 (2022) 103285

- **38 studies with 3.35 million participants were included**
- **The global incidence of perioperative cardiac arrest: 0.254% (95% CI: 0.223-0.284)**
- **The global incidence of perioperative mortality: 4.118% (95% CI: 3.568-4.668)**
- **Significant difference in anesthesia-related mortality between low middle income countries and high income countries**

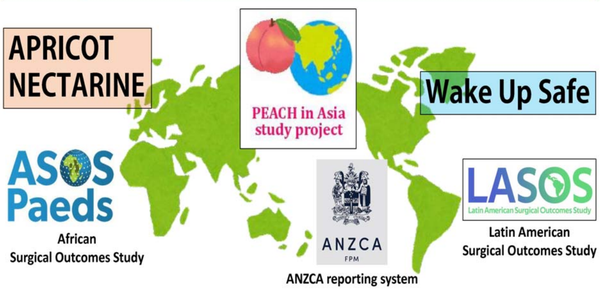
1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

You can't manage what you don't measure

- Peter F. Drucker

1. Epidemiology of peri-anesthetic complications in pediatric anesthesia

Large multicenter collaborative projects regarding pediatric peri-anesthetic adverse events



2. PEACH in Asia study

What is "PEACH in Asia study"?

Peri-**A**nesthetic morbidity in **Ch**ildren **in Asia** (**PEACH in Asia**) study: a prospective international multicenter observational study on epidemiology of severe critical events in pediatric anesthesia in Asia

PEACH in Asia study project

2. PEACH in Asia study

Design: **multinational, multicenter, prospective, observational study**

Outcome measures:

- **Primary: Incidence of severe critical events**

  ① laryngospasm, ② bronchospasm, ③ pulmonary aspiration, ④ drug error, ⑤ anaphylaxis, ⑥ cardiovascular instability, ⑦ neurological damage, ⑧ peri-anesthetic cardiac arrest, ⑨ post-anesthetic stridor

  Time Frame: Children will be followed for the duration of their anesthesia procedure and up to 60 minutes afterwards

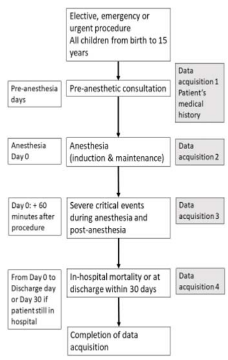
- Secondary:
  1. **Risk factors for the occurrence of severe critical events**
  2. **Consequences of the critical events: irreversible damage, in-hospital mortality**

  Time Frame: in-hospital and up to 30 days

2. PEACH in Asia study

Data acquisition

- Each participating institutions collect data over a period of **two week including weekends and after-hours**
- **The 2-week recruitment period will be chosen by each institution**
- Participating institutions will be provided with data collection sheets
- The data will be filled in the electronic case report form (e-CRF)
- e-CRF has already been created on the internationally affiliated and safe cloud system, UMIN-INDICE



Data collection flow chart

2. PEACH in Asia study

Study population

Children from birth to 15 years

✓ admitted for an inpatient or outpatient procedure under general anesthesia with or without regional analgesia

✓ admitted for a diagnostic procedure under general anesthesia (such as endoscopy, radiology, bone marrow puncture, etc.)

✓ admitted out-of-hours for emergency procedures

Exclusion criteria:

➢ Children admitted directly from the ICUs to the ORs

➢ Anesthesia procedures in the NICU or the PICU

2. PEACH in Asia study

Sample size estimation

the European APRICOT

- mean 5.2% [95% confidence interval(CI) 5.0-5.5]

In several Asian countries

- 3.3% in Singapore, 8.9% in India, and so on

↓

A minimum of **7,600** patients → a 95% CI of 1.0%

(assuming that the incidence of severe critical events is 5.2%, (ie, 95% exact CI is 4.7-5.7%), or

A minimum of **30,000** patients → a 95% CI of 0.5%

2. PEACH in Asia study

Publication policy

- After submitting grant proposal, recruitment of patients, data acquisition, cleaning and analysis of the data obtained, **authorship will be distributed according to differences in investment.**
- Each participating center including at least 5 patients can designate one collaborator that will be mentioned in the publication. Furthermore, for each additional 50 patients included, one more collaborator can be designated.
- **These collaborators will be mentioned in the manuscript and will be traceable via Pubmed.**
- Also, on request, centers will be allowed to use their data. Proposals for secondary analyses can be submitted to the Steering Committee that will need to approve those analyses and that will revise all papers originating from final analysis prior to submission.

2. PEACH in Asia study

Current protocol issued on medRxiv

medRxiv THE PREPRINT SERVER FOR HEALTH SCIENCES · CSH Cold Spring Harbor Laboratory · BMJ · Yale

https://www.medrxiv.org/content/10.1101/2022.11.13.22282262v3

PEACH in Asia: PEri-Anesthetic morbidity in CHildren in Asia: A prospective multinational multicenter observational study to investigate epidemiology of severe critical events in pediatric anesthesia in Asia

Soichiro Obara, Choon Looi Bong, Norifumi Kuratani, Zehra Serpil Ustalar Ozgan, Mahin Seyedhejazi, Shemila Abbasi, Ekta Rai, Elsa Varghese, Evangeline K Villa, Andi Ade W Ramlan, Ina Ismiarti Shariffuddin, Patcharee Sriswasdi, Pheakdey Nhoung, Vivian Yuen, Hyo-Jin Byon, Josephine S K Tan

doi: https://doi.org/10.1101/2022.11.13.22282262

2. PEACH in Asia study

The dedicated website will be updated soon

2. PEACH in Asia study

Updated information available on newsletters

As of May 12th, 2023

Questions and Answers

for the PEACH in Asia study

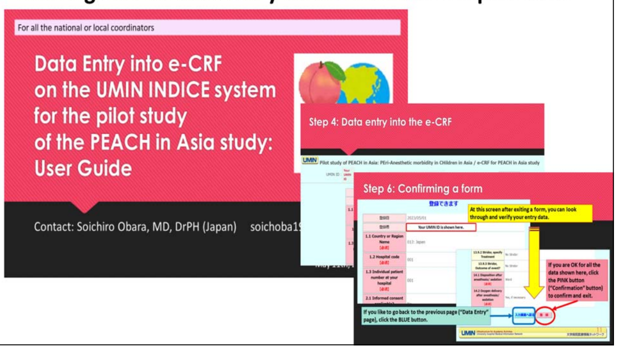
Soichiro Obara, the principal investigator of the PEACH in Asia study

Thank you all the national coordinators for contributing to the progress of our study project!

Our PEACH in Asia study is now recruiting the patients for the pilot study.

2. PEACH in Asia study

"User's guide for data entry in electronic case report form"

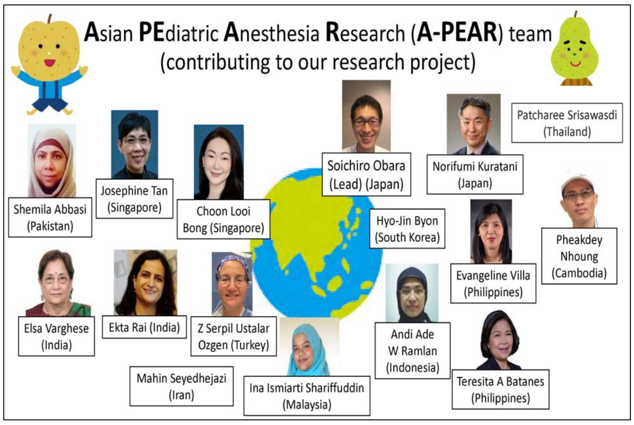


2. PEACH in Asia study

A pilot study on-going in May to June 2023

(facilities scheduled to participate as of mid-May)

Country/ Region Name	Country/ Region Code	Hospital Name	Hospital Code	Coordinator Name
Singapore	029	KK Womens' and Children's Hp	001	Choon Looi Bong, Siti Nuru Diyanah
Turkey	034	University of Acibadem	001	Z Serpil Ustalar Ozgen
Indonesia	010	Dr. Cipto Mangunkusumo Hp	001	Andi Ade W Ramlan
Malaysia	018	University of Malaya	001	Ina Ismiarti Shariffuddin
India	009	Christian Medical College	001	Ekta Rai
Pakistan	024	Aga Khan University Hp	001	Shemila Abbasi
Hong Kong	038	Hong Kong Children's Hp		Vivian Yuen, Jasmin Tong
Japan	013	Tokyo Metropolitan Otsuka Hp	001	Soichiro Obara
Japan	013	Saitama Children's Medical Center	002	Norifumi Kuratani



2. PEACH in Asia study

Research SIG's Vision

- To work on determination of the important research questions in our field of pediatric anesthesia, to hopefully trigger research endeavors in this area
- To foster the generation and propagation of research ideas in pediatric anesthesia beyond borders throughout Asia
- To collaborate with research committees of other anesthesia societies

2. PEACH in Asia study

2022-23 research SIG activities and outcomes

- Our main project: launching the internationally collaborative research project regarding prospective cohort research regarding peri-anesthetic morbidity in children in Asia, **PEACH in Asia study** project
- The Protocol was published on a pre-print server (MedRxiv)
- IRB review and approval were obtained at multi-national/regional centers in spring 2023
- A pilot study has been on-going in May to June 2023

PEACH in Asia study project

2. PEACH in Asia study

Peri-Anesthetic morbidity in Children in Asia (PEACH in Asia) study:

- will provide strategic framework for evidence-based policy-making, accountability and implementation guidance

- will work as a powerful roadmap to develop and implement data-driven education/training plans in Asia

The main study will start recruitment this summer

2. PEACH in Asia study

Any hospital caring neonates and children is welcome to participate!

Your participation is highly appreciated!

Let us work on this project together!

Kindly feel free to contact: Soichiro Obara

E-mail address: soichoba1975@gmail.com

Or, kindly contact the A-PEAR tem members

PEACH in Asia study project

The Future of Anesthesia-Related Neurotoxicity Studies: Update on the TREX Trial

Dean B. Andropoulos

Texas Children's Department of Anesthesiology, USA

Disclosures

- SmartTots Medical Officer: private-public partnership of U.S. FDA and International Anesthesia Research Society
- U.S. FDA IND holder for dexmedetomidine studies (#118058)
- SmartTots grant funding for U.S. centers
- Australian National Medical Research Council funding the DCC in Melbourne, Australia
- Italian Medicines Agency funding all sites in Italy
- Dexmedetomidine is not labeled for pediatric use by U.S. FDA

Learning Objectives

- Review the pharmacology and physiologic effects of dexmedetomidine
- Discuss dexmedetomidine neurodegenerative effects
- Describe human dexmedetomidine safety and pharmacokinetics in infants
- Detail the rationale and design for the TREX Trial

Premise for Dexmedetomidine Studies

- Gamma-aminobutyric acid (GABA) and N-methyl-D-aspartate (NMDA) binding anesthetic agents consistently cause increased neuroapoptosis and other neurodegeneration, and adverse long-term neurocognitive/behavioral deficits in animal models of the developing brain, including non-human primates
  - Sevoflurane (GABA) is the most commonly used inhaled general anesthetic in infants and children world-wide
- Sevoflurane anesthetics in human infants and children are associated with behavioral changes (not cognitive) after single or multiple exposures
- Dexmedetomidine does not produce the same neurodegenerative changes in animals, and could serve as an adjunct, or sole sedative, during general anesthesia in infants and children

Ing C, et al. Anesthesiology 2022;136:500-512

REVIEW ARTICLE

Deborah J. Culley, M.D., Editor

ANESTHESIOLOGY

Anesthesia and Developing Brains: Unanswered Questions and Proposed Paths Forward

Caleb Ing, M.D., M.S., David O. Warner, M.D., Lena S. Sun, M.D., Randall P. Flick, M.D., M.P.H., Andrew J. Davidson, M.B.B.S., M.D., F.A.N.Z.C.A., F.A.H.M.S., Laszlo Vutskits, M.D., Ph.D., Mary Ellen McCann, M.D., James O'Leary, M.D., David C. Bellinger, Ph.D., M.Sc., Virginia Rauh, Sc.D., Beverley A. Orser, M.D., Ph.D., F.R.C.P.C., Santhanam Suresh, M.D., Dean B. Andropoulos, M.D., M.H.C.M.

Anesthesiology 2022; 136:500–12

ABSTRACT

Anesthetic agents disrupt neurodevelopment in animal models, but evidence in humans is mixed. The morphologic and behavioral changes observed across many species predicted that deficits should be seen in humans, but identifying a phenotype of injury in children has been challenging. It is increasingly clear that in children, a brief or single early anesthetic exposure is not associated with deficits in a range of neurodevelopmental outcomes including broad measures of intelligence. Deficits in other domains including behavior, however, are more consistently reported in humans and also reflect findings from nonhuman primates. The possibility that behavioral deficits are a phenotype, as well as the entire concept of anesthetic neurotoxicity in children, remains a source of intense debate. The purpose of this report is to describe consensus and disagreement among experts, summarize preclinical and clinical evidence, suggest pathways for future clinical research, and compare studies of anesthetic agents to other suspected neurotoxins.

(Anesthesiology 2022; 136:500–12)

Questions regarding the safety of general anesthetic drugs in children emerged nearly 20 yr ago with the finding of neuronal apoptosis and functional deficits in rodents after exposure to these medications.[1] Over the course of the subsequent two decades, exposure to anesthetic agents during brain maturation has been found to consistently disrupt neurodevelopment in animal models.[2] In response, in December 2016, the U.S. Food and Drug Administration (Silver Spring, Maryland) issued a Drug Safety Communication regarding all commonly used anesthetics that bind to γ-aminobutyric acid and N-methyl-D-aspartate receptors.[3] The Food and Drug Administration warning that "repeated or lengthy use of general anesthetic and sedation drugs during surgeries or procedures in children younger than 3 yr old or in pregnant women during their third trimester may affect the development of

deficits in young children exposed to anesthetics and other studies finding no such differences.

Given the mixed results of the studies in children, the fundamental questions of the safety of commonly used anesthetics and whether this line of research inquiry should continue remains a source of intense debate. The purpose of this report is to provide expert consensus opinion regarding the state of the current preclinical and clinical evidence, the remaining questions, suggestions for future research, and comparisons to the evolution of research of other suspected neurotoxins, with the ultimate goal of ensuring that the millions of children who undergo procedures requiring anesthetic agents do so safely.[3–7]

Preclinical Data from Animal Models and Translation to Humans

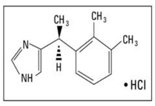
Animal studies convincingly show that general anesthetic medications induce a variety of morphofunctional alterations during brain development.[2] Although most pre-

Table 1. Advantages and Disadvantages of Potential Research Approaches

Approach	Advantages	Disadvantages
Further randomized controlled trials	Randomized controlled trials are the gold standard for proving causal effect of anesthetic exposure.	Randomized controlled trials are expensive and time consuming. Children cannot be randomized to no anesthetic, and what constitutes a "safe" anesthetic is unclear. A phenotype of injury and the ideal outcomes to evaluate are unclear. The optimal, feasible study design is not obvious.
Observational studies and causal theory	Randomized controlled trials may not be feasible in all situations. Causal theory is commonly applied to other areas such as environmental toxicity.	Observational studies are limited by the inability to distinguish effects of anesthesia from surgery and other perioperative factors, as well as issues with confounding by indication Application of causal theory relies on well-designed observational studies.
Intermediate outcomes and biomarkers	Injury could be identified at an earlier stage. Objective pre- and postexposure testing could be performed. Endophenotypes could be identified. Translation between animal models and humans could be improved.	No consistent biomarkers have been identified. Any identified biomarker would need to be correlated to a long-term clinical outcome of interest. Intermediate outcomes and biomarkers would not be able to distinguish the effects of anesthesia from surgery and other perioperative factors.
Prenatal exposures	Children may be more vulnerable to prenatal exposures. Less confounding by indication in the child as exposure is typically due to a condition in the mother rather than underlying conditions in the child.	The effects of anesthesia from uterine perfusion, inflammation, and other fetal stressors cannot be distinguished. A randomized controlled trial is unlikely to be able to randomize a mother to general anesthesia or spinal anesthesia.
Nonhuman primate studies	This is the animal model that is most similar to humans. This model can be used to evaluate questions that cannot be studied in humans.	Translation between humans and animal models is challenging. The one study that evaluated the same outcome in humans and nonhuman primates found differences in nonhuman primates but not children, although nonhuman primates had significantly longer exposures.

Anesthesiology 2022; 136:500–12

Dexmedetomidine



- Dexmedetomidine (DEX) is a novel sedative/hypnotic/analgesic agent
  - α-2 receptors: locus ceruleus and spinal cord
  - α-2: α-1 selectivity 1600:1 (clonidine 200:1)
- Minimal respiratory depression
- Reduces post-cardiac surgical tachydysrhythmias
- Reduce doses of volatile anesthetic agents (VAA), opioids, benzodiazepines

Human Data

- Less neuroapoptosis in the developing brain
- Blocks neuroapoptosis by anesthetic agents
- Neuroprotective in hypoxia-ischemia
- Neuroprotective in inflammatory states

Animal Data

Anesth Analg 2010;110:1383; Anesthesiology 2009; Ann Thorac Surg. 2011;92:964; Br J Anaesth. 2015;115:171 110:1077; Acta Anaesthesiol Scand 2010;54:710; Neurosci Lett 2006;409:128; Oxid Med Cell Longev 2015; :530371

SYSTEMATIC REVIEW

WILEY Pediatric Anesthesia

A systematic review and narrative synthesis on the histological and neurobehavioral long-term effects of dexmedetomidine

Pediatric Anesthesia. 2019;29:125–136.

Camille E. van Hoorn[1] | Sanne E. Hoeks[1] | Heleen Essink[1] | Dick Tibboel[2] | Jurgen C. de Graaff[1]

Conclusion: In animals, dexmedetomidine was found not to induce histologic injury and to show a beneficial effect when administered with another anesthetic. No clinical results on the long-term effects in children have been identified yet.

TABLE 2 Study characteristics

Article	Study design	Single dose dex (µg/kg)	Total dose dex (µg/kg)	Additional drugs	Histologic injury by dex?	Dex decreases injury caused by other anesthetic	Impaired function after dex	Less impairment after dex (behavior)
Duan 2014[17]	dex+keta vs dex+con	25	75	keta: ip 75 mg/kg	No	Yes	—	Yes
Goyagi 2016[23]	dex+sevo vs sevo+con	6.6-12.5-25	6.6-12.5-25	sevo: 3.0% 4 h	—	—	—	Yes
Han 2013[24]	dex+iso vs iso+con vs dex	25	75	iso: 0.75%; sevo: 1.2% 4 h	—	Yes	—	—
Ibrahim 2015[22]	dex+sevo vs prop+dex	3	3	sevo: 4%; prop: iv 4 mg/kg	—	No	—	—
Koo 2014[14]	dex vs con	3.0-30	39-390	keta: 20 mg/kg, 20-50 mg/kg/h 12 h	Yes	—	—	—
Lee 2017[25]	dex+sevo vs dex vs sevo	1-5-25-50-100[a]	3-15-75-150-300	sevo: 2.5% 6 h	No[a]	No	—	—
Li, J 2016[19]	dex+prop vs dex+iso vs dex	2.5-5.0-10	5-10-20	prop: iv 8.0 mg/kg+1.2 mg/kg/min	No	Yes	—	Yes
Li,Y 2014[16]	dex+iso vs iso+con vs dex	25-50-75	25-50-75	iso: 0.75% 6 h	No	Yes	—	—
Liao 2014[26]	dex+iso vs iso+con	25-50-75	75-150-225	iso: 0.75%	No	Yes	—	—
Liu 2016[18]	dex+keta vs dex vs con	10-25-50	50-125-250	keta: ip 20 mg/kg per dose	Yes	No	—	—
Lv 2017[20]	dex+prop vs con	25-50-75	25-50-75	prop: ip 100 mg/kg	—	Yes	—	—
Olutoye 2015[15]	dex+iso vs iso	1	2	iso: 1.5%-2.0% 2-3 h+ 6 h	—	Yes	—	—
Pancaro 2016[32]	dex vs keta vs con	30-45	30-45	—	Yes	—	—	—
Perez 2017[27]	dex+sevo vs con	1-5-10-25-50	3-15-30-75-150	sevo: 2.5% 6 h	—	Yes[b]	—	—
Sanders 2009[29]	dex+iso vs iso+con	1-10-25	3-30-75	iso: 0.75% 6 h	No	Yes	No	Yes
Sanders 2010[28]	dex+iso vs iso+con	25-50-75	75-150-225	iso: 0.75% 6 h	No	Yes	—	—
Su 2015[30]	dex+iso vs dex+O2 vs con	10	20	iso: 1.5% 4 h	No	Yes	No	Yes
Tachibana 2011[33]	dex vs con	5-10	5-10	—	—	—	No	—
Wang 2016[21]	dex+prop vs con	75	525	prop: ip 7 days 3x30 mg/kg/d	—	Yes	—	Yes
Zeng 2013[31]	dex vs dex+iso vs iso	25-50-75	25-50-75	iso: 0.75% 6 h	—	Yes	—	—

Pediatric Anesthesia. 2019;29:125–136.

Why Dexmedetomidine?

- Clinician's perspective:
  - Familiarity
  - Feasibility for research and adoption into clinical practice
- Widely used in pediatric anesthesia and ICU
  - Post-surgical, medical ICU, premed, opioid sparing for tonsillectomy, TIVA for spines, emergence agitation, procedural sedation
- Significant body of clinical research/clinical publications in infants/children
  - 456 in infants birth-23 months
  - 1191 in children 0-18 years
- U.S. FDA labeled for adults 18+
  - ICU sedation intubated patients
  - Procedural sedation: non-intubated patients; surgical and other procedures

BJA

British Journal of Anaesthesia, 123 (6): 839–852 (2019)

doi: 10.1016/j.bja.2019.06.026
Advance Access Publication Date: 14 October 2019
Paediatric Anaesthesia

PAEDIATRIC ANAESTHESIA

Results of a phase 1 multicentre investigation of dexmedetomidine bolus and infusion in corrective infant cardiac surgery

Athena F. Zuppa[1], Susan C. Nicolson[1], Nicole S. Wilder[2], Juan C. Ibla[3], Erin A. Gottlieb[4,a], Kristin M. Burns[5], Mario Stylianou[6], Felicia Trachtenberg[7], Hua Ni[7], Tera H. Skeen[4], Dean B. Andropoulos[4,*] on behalf of Pediatric Heart Network Investigators

NIH National Heart, Lung, and Blood Institute

PEDIATRIC HEART NETWORK

Methods: Subject Recruitment, N = 124

- Inclusion criteria: Neonates/Infants 0-180 days
- Stratification: Neonates 0-21 days; Infants 22-180 days
- Corrective two-ventricle surgery with CPB:
  - Arterial switch for dextrotransposition of the great arteries (D-TGA)
  - Ventricular septal defect without arch obstruction
  - Tetralogy of Fallot
- Major exclusion criteria
  - <37 weeks (neonates), <36 weeks (infants), extracardiac anomalies affecting safety/PK, previous DEX/clonidine, AV block, bradycardia, renal/liver dysfunction, cardiac arrest/ECMO
- Enrollment in 4 U.S. centers
  - Texas Children's Hospital, Children's Hospital of Philadelphia, C.S. Mott Children's Hospital, Boston Children's Hospital

4

Results: Safety Events

- 5 adjudicated safety events (4.1%, 95% CI 1.8-9.2%)
  - Two junctional bradycardia (65-109 BPM)
  - Two 2nd-3rd degree AV block (85-95 BPM)
    - All 4 with temporary pacing (30 minutes to 48 hours)
    - 3 of 4 receiving digoxin, amiodarone, or β-adrenergic blocking drugs
  - One hypotension: multifactorial etiology
- All safety outcomes in Infant age group
- No consistent relationship with DEX plasma level (126-977 pg/ml)

8

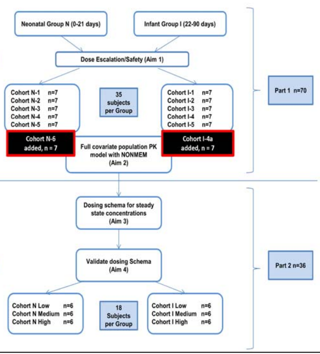
Methods: Study Protocol

Dose Escalation

PK Modeling

Dosing Schema

Model Validation



5

Results: PK Parameters, N=119 Subjects

	Allometric weight normalised model		Linear weight normalised model	
	AIC=16 328		AIC=16 318	
Parameter	Point estimate (NONMEM SE%)	95% CI from LLP	Point estimate (NONMEM SE%)	95% CI from LLP
CLpre (ml min^{-1} 70 kg^{-1})	1240 (14)	1030, 1470	2580 (14)	1950, 3400
CLcpb (ml min^{-1} 70 kg^{-1})	74.1 (42.1)	59, 126	142 (53.5)	130, 300
CLpost (ml min^{-1} 70 kg^{-1})	623 (7.9)	560, 670	1240 (8.39)	1020, 1400
V1pre(L 70 kg^{-1})	132 (26.4)	109, 152	139 (25.8)	94.6, 202
V1cpb (L 70 kg^{-1})	115 (14.7)	106, 136	116 (14.9)	103, 146
V1post (L 70 kg^{-1})	155 (7.61)	141, 167	159 (7.92)	129, 185
Qpre (ml min^{-1}/70 kg^{-1})	2300 (96.1)	50, 6800	4120 (107)	100, 400 000
Qcpb (ml min^{-1} 70 kg)	2980 (18.7)	2410, 3710	6160 (16.9)	4300, 8400
Qpost (ml min 70 kg^{-1})	209 (18.6)	161, 270	422 (20.3)	280, 700
V2pre(L 70 kg^{-1})	78.9 (36)	19.5, 154	69.6 (43)	5, 90
V2cpb (L 70 kg^{-1})	144 (12.4)	135, 162	147 (12.4)	101, 149
V2post (L 70 kg^{-1})	105 (9.4)	92.3, 113	97 (10.6)	78.6, 130
Age CLpost 50% mature (days)	1.77 (25.4)	1.11, 2.28	1.29 (33.9)	0.4, 2
Temp effect V1cpb	−1.6 (6.6)	−1.69, −1.41	−1.57 (6.43)	−1.73, −1.21

9

Results: Dosing Recommendations

Age Group	Target Plasma Concentration (pg/ml)	Initial Loading Dose (mcg/kg)	Infusion 1: pre-CPB, first 60 min CPB (mcg/kg/hr)	Loading Dose to CPB Prime (mcg/ml)	Infusion 2: after 60 min CPB until end CPB (mcg/kg/hr)	Infusion 3: 60 min after CPB (mcg/kg/hr)
Neonate	200	0.24	0.22	0.004	0.04	0.14
Neonate	500	0.6	0.55	0.01	0.1	0.35
Neonate	700	0.84	0.77	0.014	0.14	0.49
Neonate	1000	1.2	1.1	0.02	0.2	0.7
Infant	200	0.29	0.26	0.005	0.05	0.17
Infant	500	0.72	0.66	0.012	0.12	0.42
Infant	700	1.01	0.92	0.017	0.17	0.59
Infant	1000	1.44	1.32	0.024	0.24	0.84

Based on CPB low temp of 32°C and 90-minute CPB time

British Journal of Anaesthesia, 123 (6): 839–852 (2019)

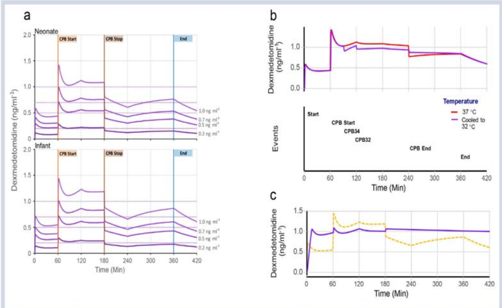
12

Playing with dexmedetomidine pharmacokinetics!

Gregory Hammer[1] and Steven L. Shafer[1,2,*]

British Journal of Anaesthesia, 124 (3): 238–240 (2020)

[1]Department of Anesthesiology, Perioperative and Pain Medicine, Stanford University, Palo Alto, CA, USA and
[2]Department of Bioengineering and Therapeutic Sciences, University of California, San Francisco, CA, USA



Rationale for TREX Trial

- Opioids and alpha-2 agonists do not cause the same neurodegenerative changes seen in animal models with other GAs or sedatives
- Neurodevelopmental outcome data in longer anesthetic exposures, i.e. >2-3 hours, is lacking
  - Short single exposures, multiple exposures: behavioral but not cognitive changes
  - GAS, MASK, PANDA studies
- A pilot study of dexmedetomidine/remifentanil/combined with caudal anesthetic for anesthetics greater than 2 hours was feasible in 60 subjects less than 1 year of age
- For the randomized trial, low-dose sevoflurane was added to dexmedetomidine/remifentanil because of high rate of light anesthesia in the pilot study
- Standard dose sevoflurane is commonly utilized in daily practice for these anesthetics

TREX Pilot Study: (Toxicity of Remifentanil-DEXmedetomidine)

Received: 16 March 2018 | Revised: 31 October 2018 | Accepted: 8 November 2018
DOI: 10.1111/pan.13544

RESEARCH REPORT

WILEY Pediatric Anesthesia

An open label pilot study of a dexmedetomidine-remifentanil-caudal anesthetic for infant lower abdominal/lower extremity surgery: The T REX pilot study

Peter Szmuk[1,2] | Dean Andropoulos[3] | Francis McGowan[4] | Ansgar Brambrink[5] | Christopher Lee[6] | Katherine J. Lee[7] | Mary Ellen McCann[8] | Yang Liu[3] | Rita Saynhalath[1] | Choon Looi Bong[9] | Brian J. Anderson[10] | Charles Berde[8] | Jurgen C. De Graaff[11] | Nicola Disma[12,13] | Dean Kurth[4] | Andreas Loepke[4] | Beverley Orser[14] | Daniel I. Sessler[2] | Justin J. Skowno[15] | Britta S. von Ungern-Sternberg[16] | Laszlo Vutskits[17] | Andrew Davidson[18]

Pediatric Anesthesia. 2019;29:59–67.

TREX Pilot Study (Toxicity of Remifentanil-DEXmedetomidine)

- 8 sites enrolled subjects: (1-20), N = 60, age < 1 year
- Eye-opening times about 7 minutes
- Most had excellent analgesia in PACU, most discharged <60 minutes
- No protocol abandonment in 56 subjects
- No serious adverse events: mild/moderate hypotension (25%) and bradycardia (16%)
- ***80% had "rescue" treatment for light anesthesia (movement/hypertension)***
- ***Protocol is feasible: 87.5% of patients with functioning caudal required no sevoflurane or propofol rescue***

Pediatric Anesthesia. 2019;29:59–67.

Dexmedetomidine/Remifentanil/Low Dose Sevo vs. Standard Dose Sevoflurane RCT: TREX Trial

- Children <2 years undergoing 2 hours or longer of surgery time, 2+ hours of anesthesia time
- Dexmedetomidine/remifentanil/low dose sevoflurane (0.3-0.6%ET), vs. standard higher dose sevoflurane (2.5-3.0%ET)
- Age 3 years: battery of neurodevelopmental tests
- Up to 20 sites in USA, Australia, Europe
- Weschler Full-scale IQ is primary outcome; difference of 5 points significant
- 450 needed to enroll to yield 380 evaluable subjects

TREX: Toxicity of Remifentanil-DEXmedetomidine Trial

- Phase III randomized, active controlled, parallel group, assessor blinded, multicenter, superiority trial of:
  - Low-dose sevoflurane/DEX/remifentanil: DEX 1 mcg/kg load, 1 mcg/kg/hr infusion; remifentanil 1 mcg/kg load, 0.1 mcg/kg/min or greater infusion; sevoflurane 0.3-0.6% ET or less
  - Standard dose sevoflurane: 2.5-3.0% ET or greater
- Neuraxial/regional/local anesthesia, morphine (end of case) allowed
- Inclusion: < 2 years, surgery time of 2 hours, total anesthesia/OR time 2+ hours
  - Decreased from 2.5 hours due to slow enrollment
- Exclusion: Previous or future GA >2 hours before age 3 years; neurodevelopmental issues, cardiac or neuro disease

TREX: Primary Objective

- Determine if low dose sevoflurane/dexmedetomidine/remifentanil is superior to standard dose sevoflurane anesthesia in terms of global cognitive function assessed by the full-scale IQ score of the Weschler Preschool and Primary School Intelligence Scale assessed at 3 years of age

TREX Secondary Objectives

- A range of other neurodevelopmental tests performed at 3 years of age including subscales of general cognitive functioning, language, executive function, memory, adaptive behavior, clinical behavior and social skills
- Diagnosis of any neurodevelopment disorder at 3 years of age
- Additional secondary outcomes:
  - Incidence of intraoperative hypotension and bradycardia
  - Postoperative pain
  - Time to recovery

TREX Enrollment

- 450 subjects have been enrolled, 190 in each group required to have 90% power to detect a difference of 5 points based on 2-sided test with alpha = 0.05
  - 15% loss to follow-up anticipated
- Enrollment started August 2017
- Pandemic slowed enrollment but additional centers started, especially Italy
- 450 target enrolled on April 21, 2023
- More than 100 with 3-year follow-up completed
- Anticipate completing most all neurodevelopmental assessments end of 2025
- No serious adverse events related to the study

Participating Centers and Enrollment

- United States:
  - Children's Medical Center, Dallas: 85
  - Texas Children's Hospital, Houston: 60
  - Boston Children's Hospital: 25
  - Children's Hospital of Philadelphia: 4
  - Cleveland Clinic: 4
- Australia:
  - Perth Children's Hospital: 23
  - Queensland Children's Hospital: 25
  - Children's Hospital Westmead: 19
  - Royal Children's Hospital, Melbourne: 13
  - Flinders Medical Centre: 14
  - Women and Children's Hospital, Adelaide: 11
  - Sydney Children's Hospital: 13

Participating Centers and Enrollment (cont'd)

- Italy:
  - Istituto Giannina Gaslini: 60
  - Azienda Ospedaliero Universitaria Pisana: 12
  - Azienda Ospedaliero-Universitaria Meyer: 21
  - Ospedale Bambino Gesù: 4
  - Azienda Ospedaliero-Universitaria di Bologna: 7
  - Presidio Ospedale Infantile C.Arrigo Azienda Ospedalier, Italy: 15
  - Vittore Buzzi Children's Hospital, Italy: 29
  - Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico - Clinica Mangiagalli, Italy: 6

Conclusions

- Dexmedetomidine does not induce the same histologic injury, and ameliorates the effects of other anesthetics in pre-clinical models
- Dexmedetomidine pharmacokinetics and safety are well established in infant populations, including congenital heart disease
- A dexmedetomidine-based anesthetic, with low-dose sevoflurane is safe and feasible
- The TREX Trial enrollment is complete and will add human neurodevelopmental outcome data with a dexmedetomidine-based anesthetic vs. conventional sevoflurane anesthetic

Session 4.

Issues We Are Facing & Need to Overcome

Chair(s): Vibhavari Naik (India)

Hee-Soo Kim (Korea)

Environmental Impact of Anesthesia (Virtual)

Diane Gordon

Children's Hospital Colorado, USA

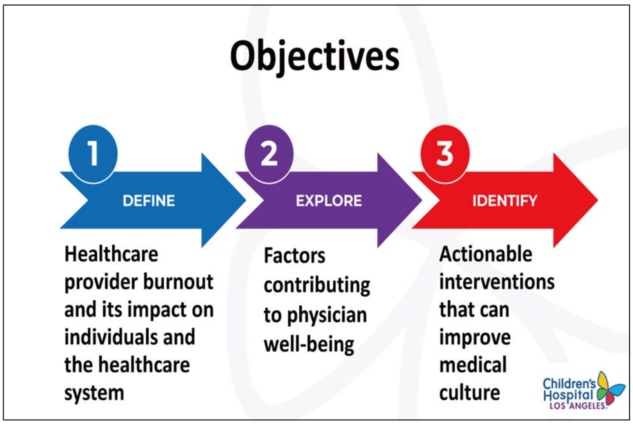
Learning Objectives

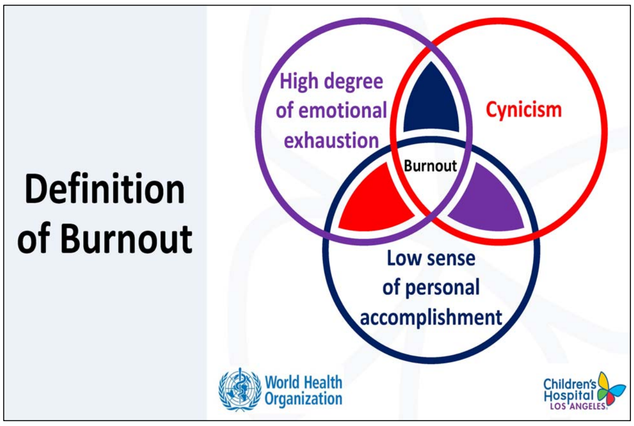
1. Describe the chemical properties of volatile anesthetic agents and nitrous oxide that are responsible for their detriment to the atmosphere
2. Summarize the arguments supporting use of low fresh gas flows when using volatile agents, including the science that refutes higher flow suggestions for sevoflurane.

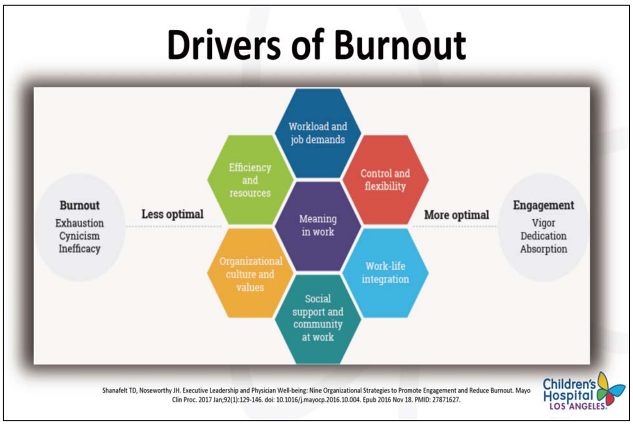
Healing the Culture of Medicine

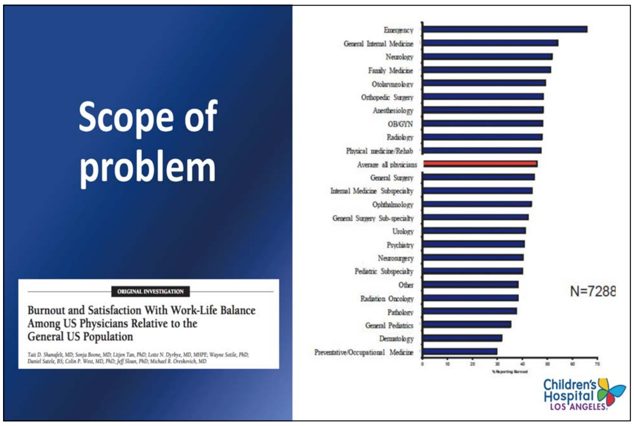
Rebecca Donovan Margolis

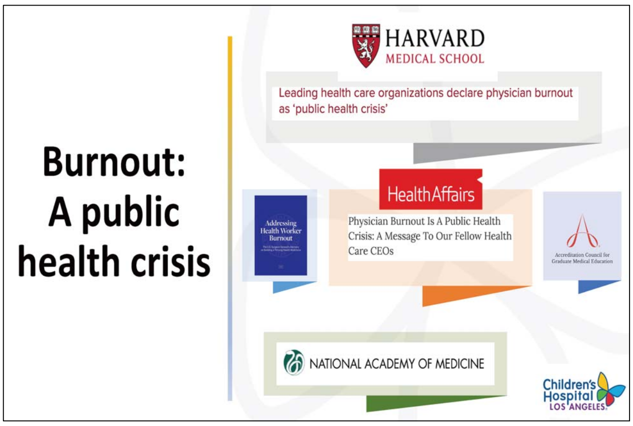
Department of Anesthesiology and Critical Care Medicine, Children's Hospital Los Angeles, University of Southern California Keck School of Medicine, USA

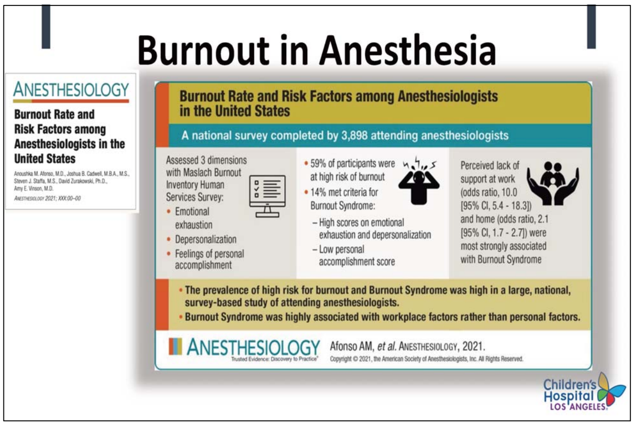




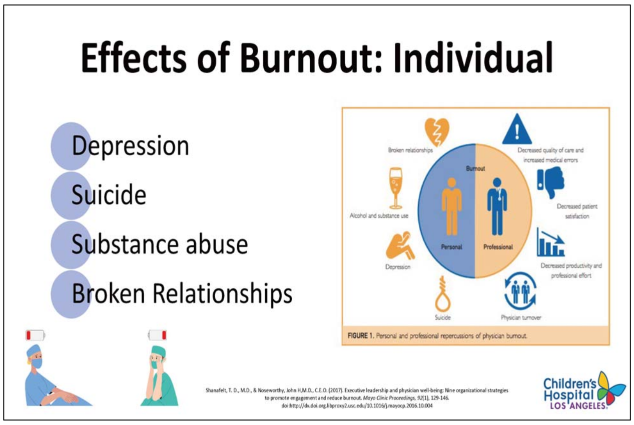







Burnout in Anesthesia
ANESTHESIOLOGY
Burnout Rate and Risk Factors among Anesthesiologists in the United States
Burnout Rate and Risk Factors among Anesthesiologists in the United States
A national survey completed by 3,898 attending anesthesiologists
Assessed 3 dimensions with Maslach Burnout Inventory Human Services Survey:
• Emotional exhaustion
• Depersonalization
• Feelings of personal accomplishment
• 59% of participants were at high risk of burnout
• 14% met criteria for Burnout Syndrome:
– High scores on emotional exhaustion and depersonalization
– Low personal accomplishment score
Perceived lack of support at work (odds ratio, 10.0 [95% CI, 5.4 - 18.3]) and home (odds ratio, 2.1 [95% CI, 1.7 - 2.7]) were most strongly associated with Burnout Syndrome
• The prevalence of high risk for burnout and Burnout Syndrome was high in a large, national, survey-based study of attending anesthesiologists.
• Burnout Syndrome was highly associated with workplace factors rather than personal factors.
ANESTHESIOLOGY
Afonso AM, et al. ANESTHESIOLOGY, 2021.
Children's Hospital LOS ANGELES


Burnout: it's not just Americans
ICPH 2022
Children's Hospital LOS ANGELES


Effects of Burnout: Individual
Depression
Suicide
Substance abuse
Broken Relationships
FIGURE 1. Personal and professional repercussions of physician burnout.
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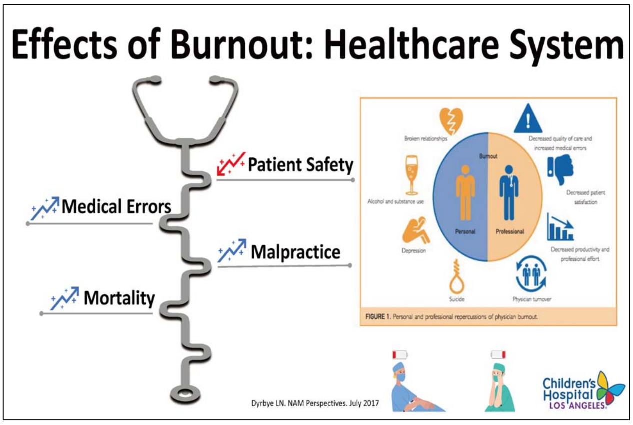
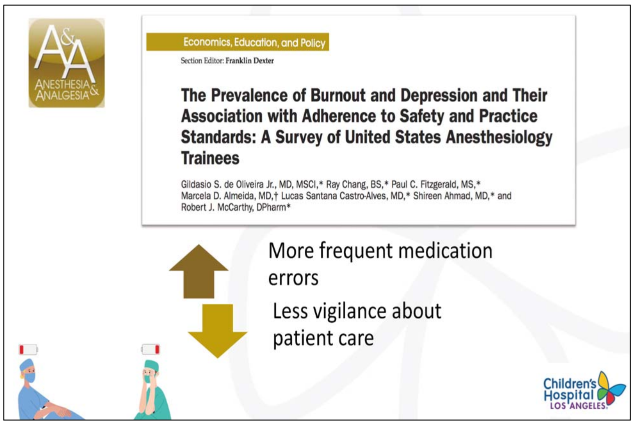

Effects of Burnout: Healthcare System
Patient Safety
Medical Errors
Malpractice
Mortality
FIGURE 1. Personal and professional repercussions of physician burnout.
Dyrbye LN. NAM Perspectives. July 2017
Children's Hospital LOS ANGELES


A&A ANESTHESIA & ANALGESIA
Economics, Education, and Policy
Section Editor: Franklin Dexter
The Prevalence of Burnout and Depression and Their Association with Adherence to Safety and Practice Standards: A Survey of United States Anesthesiology Trainees
Gildasio S. de Oliveira Jr., MD, MSCI,* Ray Chang, BS,* Paul C. Fitzgerald, MS,* Marcela D. Almeida, MD,† Lucas Santana Castro-Alves, MD,* Shireen Ahmad, MD,* and Robert J. McCarthy, DPharm*
More frequent medication errors
Less vigilance about patient care
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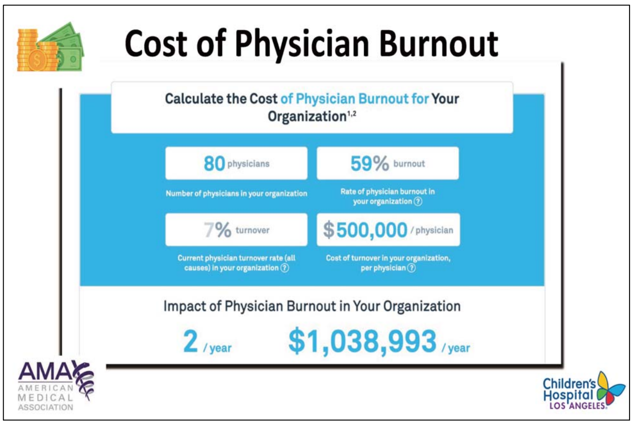
Cost of Physician Burnout
Calculate the Cost of Physician Burnout for Your Organization
80 physicians
59% burnout
Number of physicians in your organization
Rate of physician burnout in your organization
7% turnover
$500,000 / physician
Current physician turnover rate (all causes) in your organization
Cost of turnover in your organization, per physician
Impact of Physician Burnout in Your Organization
2 / year
$1,038,993 / year
AMA AMERICAN MEDICAL ASSOCIATION
Children's Hospital LOS ANGELES


Staffing Shortages
HELP WANTED
One in five
healthcare workers have left medicine since the start of the pandemic
https://www.theatlantic.com/health/archive/2021/11/the-mass-exodus-of-americas-health-care-workers/620713/
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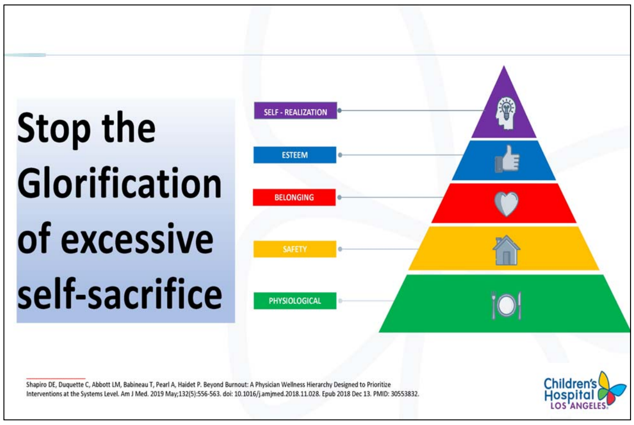
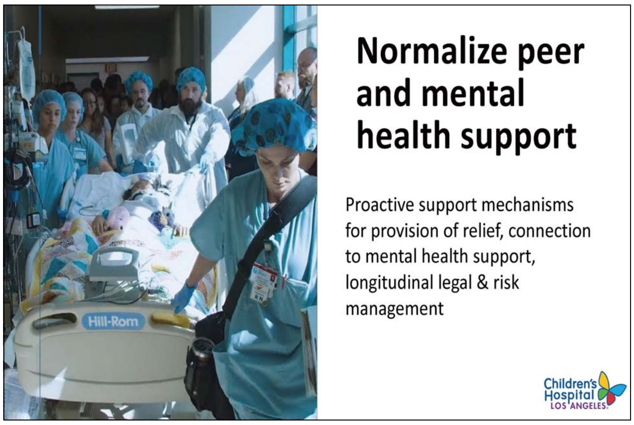
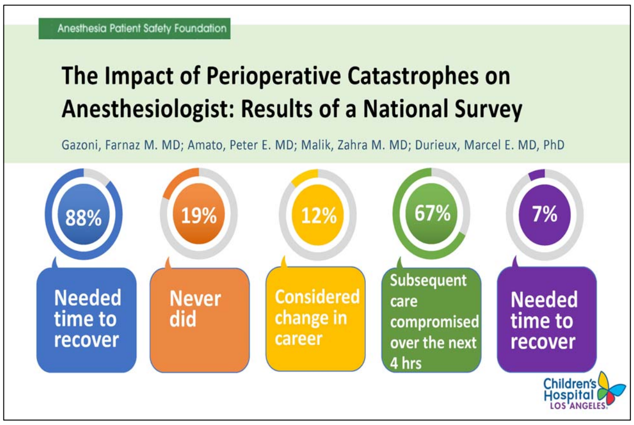
Well-Being 2.0: Sustainable Culture
Culture Change
Physician well-being
The Wicked Problem of Physician Well-Being
Children's Hospital LOS ANGELES


What can we do?
Stop the glorification of excessive self-sacrifice
Stop blaming and shaming doctors
Normalize peer and mental heath support
Stop the strip mining
Empower physicians to be the architects of their own environment
The Wicked Problem of Physician Well-Being
Children's Hospital LOS ANGELES


Stop the Glorification of excessive self-sacrifice
SELF - REALIZATION
ESTEEM
BELONGING
SAFETY
PHYSIOLOGICAL
Shapiro DE, Duquette C, Abbott LM, Babineau T, Pearl A, Haidet P. Beyond Burnout: A Physician Wellness Hierarchy Designed to Prioritize Interventions at the Systems Level. Am J Med. 2019 May;132(5):556-563. doi: 10.1016/j.amjmed.2018.11.028. Epub 2018 Dec 13. PMID: 30553832.
Children's Hospital LOS ANGELES


Stop blaming and shaming doctors
Impact of lawsuits
Physicians involved in a lawsuit are at ↑ risk for stress, personal consequences, and burnout
Litigation and patient safety & quality
Litigation has not been shown to improve patient safety or quality of care
Liability reform
Liability reform is necessary to uphold patient safety while minimizing trauma to doctors
Children's Hospital LOS ANGELES


Hill-Rom
Normalize peer and mental health support
Proactive support mechanisms for provision of relief, connection to mental health support, longitudinal legal & risk management
Children's Hospital LOS ANGELES


Anesthesia Patient Safety Foundation
The Impact of Perioperative Catastrophes on Anesthesiologist: Results of a National Survey
Gazoni, Farnaz M. MD; Amato, Peter E. MD; Malik, Zahra M. MD; Durieux, Marcel E. MD, PhD
88%
Needed time to recover
19%
Never did
12%
Considered change in career
67%
Subsequent care compromised over the next 4 hrs
7%
Needed time to recover
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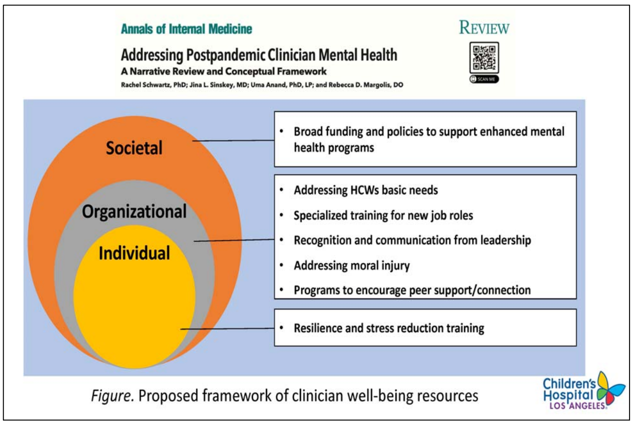
Annals of Internal Medicine
REVIEW
Addressing Postpandemic Clinician Mental Health
A Narrative Review and Conceptual Framework
Rachel Schwartz, PhD; Jina L. Sinskey, MD; Uma Anand, PhD, LP; and Rebecca D. Margolis, DO
Societal
Organizational
Individual
Broad funding and policies to support enhanced mental health programs
Addressing HCWs basic needs
Specialized training for new job roles
Recognition and communication from leadership
Addressing moral injury
Programs to encourage peer support/connection
Resilience and stress reduction training
Figure. Proposed framework of clinician well-being resources
Children's Hospital LOS ANGELES


Stop the strip mining
Harness intrinsic motivators
Clinicians are a finite resource and must be valued as such
Healthcare institutions must adopt long-term strategies focused on retention by investing in and supporting employees
Lubarsky DA, French MT, Gitlow HS, Rosen LF, Ullmann SG. Why Money Alone Can't (Always) "Nudge" Physicians: The Role of Behavioral Economics in the Design of Physician Incentives. Anesthesiology. 2019;130(1):154-170. doi:10.1097/ALN.0000000000002373
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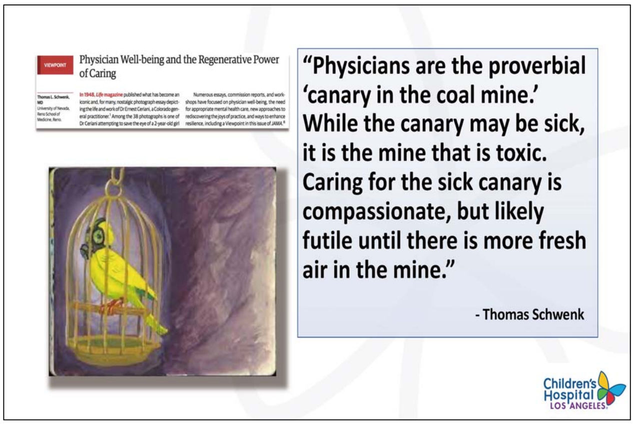
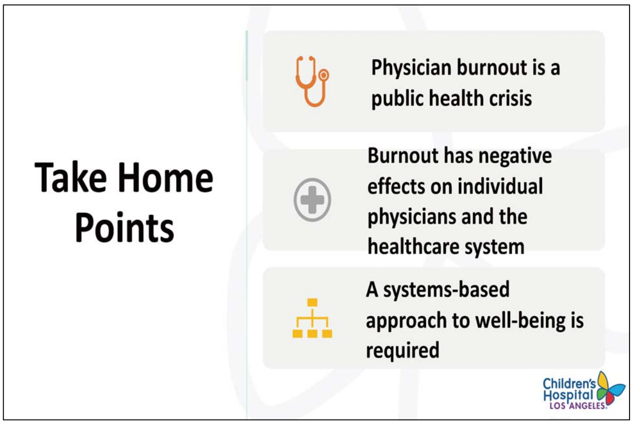
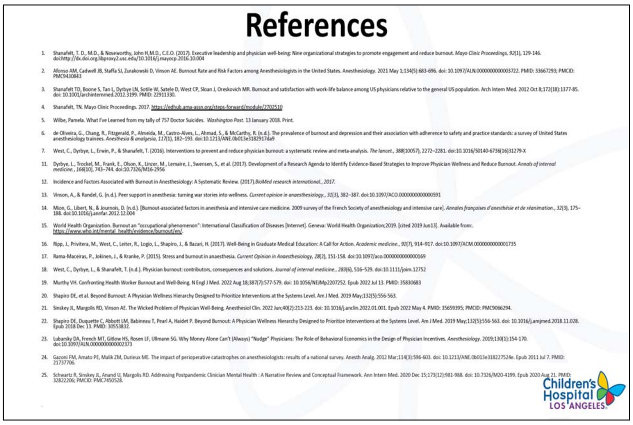
Empower physicians to be the architects of their own environment
Early leadership training
Leadership roles must come with protected time
Children's Hospital LOS ANGELES



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Challenges in providing safe anaesthesia to children in LMIC's

Rebecca Jacob

(Retired) Christian Medical College, India

Access to safe anaesthesia and surgery for patients of all ages should be considered a basic human right, but this is not available to a large segment of the world's population. Many developing and underdeveloped countries spend a very small portion of their GDP on health care, and this is the greatest barrier to providing good anaesthetic services and surgical care. Different countries have different problems and there are often regional variations within the same country. Some LIC's have very well equipped and staffed hospitals in major cities while the rural poor suffer. Often the problem is maldistribution of supplies rather than absolute shortage

Surgery is critical to the health of the population and safe anaesthesia is a mandatory component of safe surgical care. There is much that can be done to make sure that the existing resources are used efficiently. The WHO, acknowledging the fact that the global volume of surgery is significant and adverse events resulting from surgeries constitute a significant public health concern, launched the Patient Safety Initiative in 2004 and the Safe Surgery Saves Lives initiative in 2008. With these initiatives, they have set a core set of safety standards that can be applied to all countries in all settings. The Surgical Safety Check List, together with the WHO-WFSA International Standards for a Safe Practice of Anesthesia (2010) enhanced patient safety cultures but Pediatric Anaesthesia in LMIC's has not kept pace with advances made in developed countries and International standards for Safe Anaesthesia Practice adopted by the WFSA are seldom met.

The element of safety is particularly important in anaesthesia because anaesthesia is not in itself therapeutic and is intrinsically hazardous.

Problems faced in delivering safe anaesthesia in LMIC's

- The patients
- Spectrum and nature of the disease
- Personnel – staffing
- Facilities
- Equipment and supplies
- Drugs – poor supply, quality and perhaps, out dated

The patients: are often, anemic, undernourished children of economic crises, war or natural disasters. Fear, superstition, interference by 'local healers', poor understanding of medical problems, poor education and poor access to medical care often results in delayed presentation.

Spectrum and nature of the disease: Often marasmic, anemic, undernourished, riddled with tuberculosis or HIV

Personnel – staffing: Anaesthesia is not perceived as an attractive career for many undergraduates who have little or no exposure to the subject during their studies Anaesthesia does not enjoy a high profile and lacks the voice to demand access to basic resources in developing countries. Anaesthesia providers are often too busy providing clinical services to find the time to approach the 'powers that be' for basic requirements. There is a critical shortage of manpower and this proves a barrier to progress. Anaesthesia is often delivered by nurses or non-technical people. Supervision is invariably inadequate In some countries surgery is performed without the 'luxury' of an anaesthetist Access to textbooks and journals are limited and internet access is non-existent. Most 'trained' anaesthetists are afraid to deal with children especially neonates and infants because of perceived difficulty or fear Invariably a 'paediatric anaesthetist is one who shows an interest in children, likes children or is just allocated to 'do' children on a particular day. A trained Paediatric Anaesthetist is, therefore, a luxury

Facilities and Drugs

Operating Rooms are often poorly equipped, non-air conditioned, with poor facilities for sterilization of equipment. Water supply and electricity is erratic Supplies of anaesthetic gases and oxygen supplies unreliable and erratic Drugs are in short supply and are often outdated IV fluids- their choice and availability is limited. Halothane and Isoflurane are the most commonly used inhalational agents. Ketamine and paracetamol most often used analgesics. Narcotics like morphine are often unavailable or its use is restricted Choice of neuromuscular drugs is limited and often a 'reversal' drug like neostigmine is unavailable Regional anaesthesia has benefits like safety, cost savings and analgesia but is often not used in children for lack of training, fear of failure or non-availability of drugs and disposables etc.

Blood availability and safety

Fewer than 30% of developing countries have nationally coordinated blood transfusion services. Screening of donors is often not done. Many do not perform even rudimentary tests for diseases such as hepatitis and HIV Storage of blood is difficult especially as electricity supply is often erratic.

Equipment

Electricity is unreliable and reliable functional 'back up' generators are often unavailable Sterilization of re- useable equipment is the norm but availability and performance of sterilizers is unreliable Recycling of disposable equipment such as endotracheal tubes is also often relied on General facilities for infection control such as running water, disinfectants and gloves is also unreliable Essential equipment to provide safe anaesthesia for neonates and infants are in short supply from appropriately sized endotracheal tubes, small IV cannulae, appropriate airways, laryngoscopes and syringe pumps.

Monitoring is often basic – a precordial stethoscope and a finger on the pulse is often all that is available. The Global oximetry project has helped with providing reasonably priced pulse oximeters.

Anaesthesia machines are of 2 categories

1. Modern, sophisticated electronic machines. These are often donated by well meaning donors
   - They require electricity,
   - operating manuals that require to be understood (especially if in a foreign language),
   - regular maintenance by individuals trained to do so.
   - service contracts do not often hold good in remote rural locations.
   - often discarded at the first sign of trouble

   Poorly understood and poorly maintained equipment becomes hazardous and potentially life threatening

2. Simple, durable and safe
   - versatile, easily understood and easy to use
   - able to function even if there is no electricity and if there are no cylinders available
   - robust,
   - able to withstand extreme climate conditions,
   - Inexpensive, economical and easily maintained by locally available skills

3. Oxygen concentrators

Visiting Providers

Often come with no idea of the facilities or the needs of the local people or with preconceived ideas that 'they know best'. However some countries organize well staffed 'missions' to remote areas

Solutions?

Knowing that there is a dearth of qualified paediatric anaesthesia providers especially in rural areas, I would look at what measures need to be taken to bridge the 'demand/supply' gap of qualified, committed anaesthesia providers in those areas

- Can we bring about quality improvement with education?
- Establish protocol driven clinical outcomes leading to standardization of safety protocols.

But who is to ensure that these are followed?

- Can we find a way to 'match' safety policies to implementation across vast and diverse countries or diverse regions in the same country?

- How do we gauge whether these policies and protocols are working?

What 'outcome measures' would be appropriate?

Room B

ASPA 2023

Session 1.

Optimization of Intraoperative Ventilation in Children

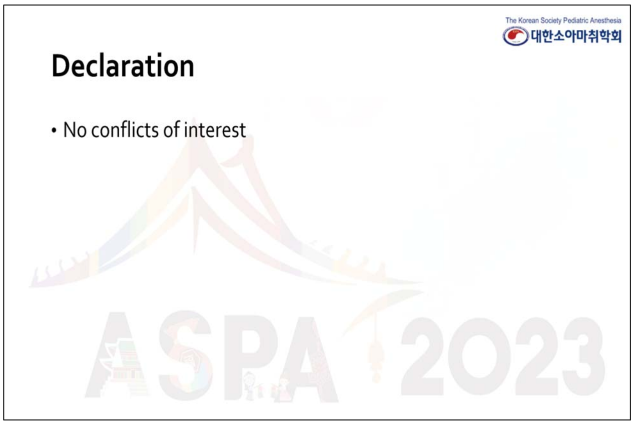
Chair(s): Ekta Rai (India)

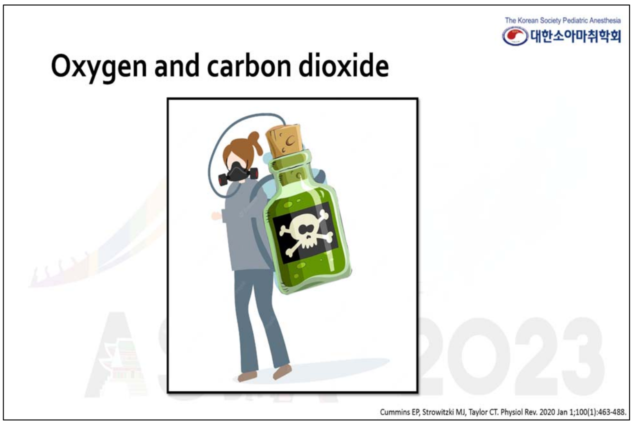
Chul-Ho Chang (Korea)

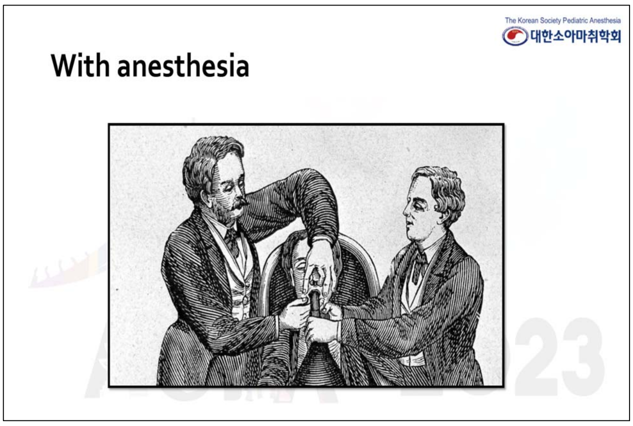
Optimal Target of O_2 and CO_2

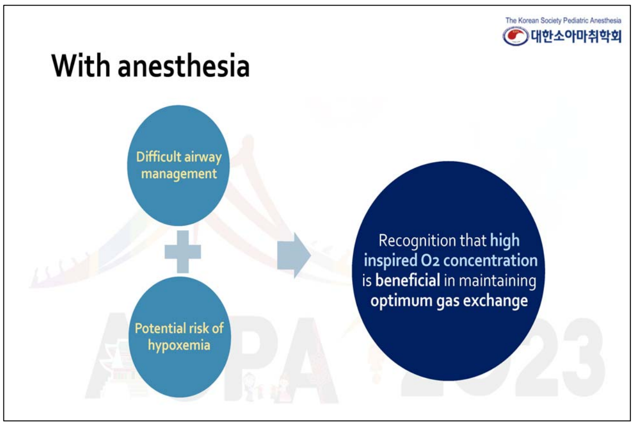
Sung-Ae Cho

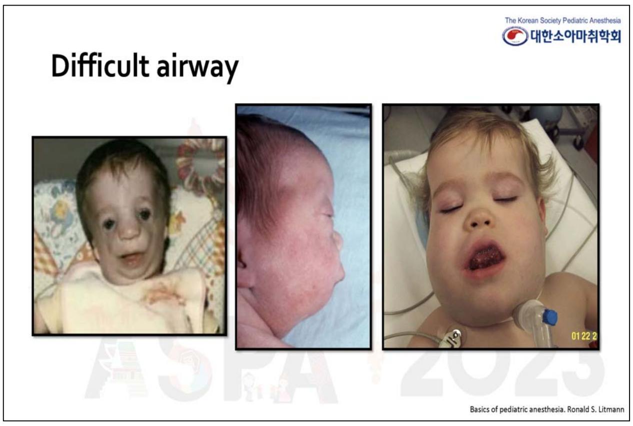
Department of Anesthesiology and Pain Medicine, College of Medicine, Konyang University, Korea











With anesthesia

- Several oxygen delivery method
  - Invasive involuntary; Intubation, LMA, bronchoscopy.....
  - noninvasive self breathing; CPAP, nasal cannular, oxygen mask....



A Practice of Anesthesia for Infants and Children, sixth edition; Cote, Lerman, Anderson
Pediatric and neonatal mechanical ventilation; Rimensberger

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Optimal oxygen

- The Optimal Arterial Oxygen Tension (Pao2)

  at the Lowest Inspired Oxygen Concentration (Fio2)

- With **ABGA** – **direct** method
  - PaO_2, FiO_2, A-a gradient
- Without ABGA – **indirect** method; **SpO2**
  - Measure **arterial oxyhemoglobin saturation,** not arterial oxygen partial pressure

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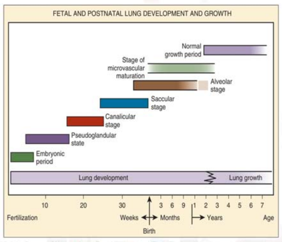
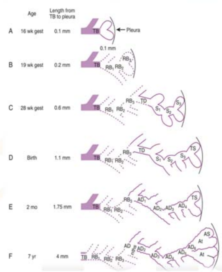
Prenatal Development of the Lungs





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BOX 3-1 Mechanism of Continuous Neonatal Breathing

- The onset of breathing activities occurs not at birth but in utero as a part of normal fetal development.
- The clamping of the umbilical cord initiates rhythmic breathing.
- Relative hyperoxia with air breathing, compared with low fetal Pa_{O_2}, augments and maintains continuous and rhythmic breathing.
- Continuous breathing is independent of the level of Pa_{CO_2}.
- Breathing is unaffected by carotid denervation.
- Hypoxia depresses or abolishes continuous breathing.

TABLE 3-1 Normal Blood-Gas Values

	Pa_{O_2} (mm Hg)	Sa_{O_2} (%)	Pa_{CO_2} (mm Hg)	pH
Pregnant woman at term	88*	96	32	7.40
Umbilical vein	31	72*	42	7.35
Umbilical artery	19	38*	51	7.29
1 hour of life (artery)	62	95	28	7.36
24 hours of life (artery)	68	94	29	7.37
Child and adult (artery)	99	97	41	7.40

*Estimated values.

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the level of PO2 at which SaO2 is 50%, indicating the affinity of hemoglobin for oxygen

Age	P_{50} (mm Hg)	Percent Saturation at Venous Oxygen Tension of 40 mm Hg	Hemoglobin (g/100 mL)	Oxygen Unloaded* (mL/100 mL)
1 day	19.4	87	17.2	1.84
3 wk	22.7	80	13.0	2.61
6–9 wk	24.4	77	11.0	2.65
3–4 mo	26.5	73	10.5	3.10
6 mo	27.8	69	11.3	3.94
8–11 mo	30.0	65	11.8	4.74
5–8 yr	29.0	67	12.6	4.73
9–12 yr	27.9	69	13.4	4.67
Adult	27.0	71	15.0	4.92

Increase

Decrease

*Assumes arterial oxygen saturation of 95%.
Data from Oski FA. Designation of anemia on a functional basis. *J Pediatr*. 1973a83:353.

TABLE 3-5 Hemoglobin Requirements for Equivalent Tissue Oxygen Delivery

	P_{50} (mm Hg)	Hemoglobin for Equivalent O_2 Delivery (g/dL)						
Adult	27	7	8	9	10	11	12	13
Infant >6 mo	30	5.7	6.5	7.3	8.2	9.0	9.8	10.6
Neonate <2 mo	24	10.3	11.7	13.2	14.7	16.1	17.6	19.1

Data calculated from Motoyama EK, et al. Functional basis of childhood anemia [abstract]. *Am Soc Anesthesiology*. 1974;283.

Hmmmm.....

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The purpose of O2 supplement

- In pediatrics
  - Indication; for **correction hypoxemia** (low oxygen content in the blood)
- In anesthesiology
  - Indication; for **adequate tissue oxygenation during perioperative period**

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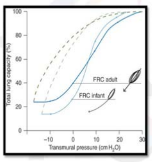
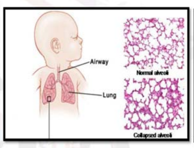
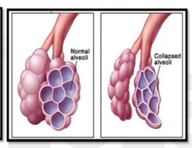
Pediatric anesthesia

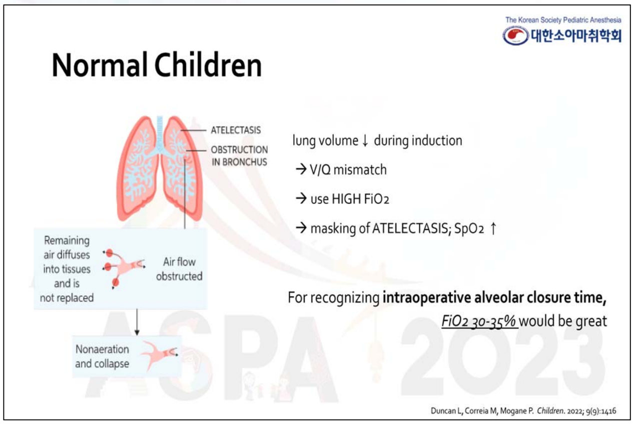
- Adequate tissue oxygenation during perioperative period
- **Prevention and treatment for hypoxemia**
- m/c hypoxemia during anesthesia : d/t *V/Q mismatch*
  - In this case, high FiO2 can seriously affect hypoxemia







Trachsel D, Svendsen J, Erb TO, von Ungern-Sternberg BS. Br J Anaesth. 2016 Aug;117(2):151-63.


The Korean Society Pediatric Anesthesia
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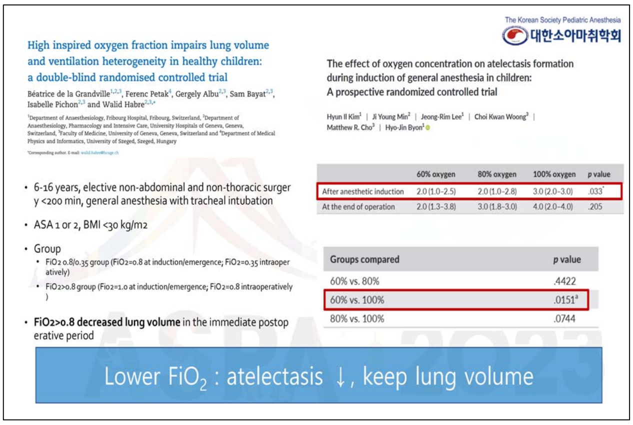
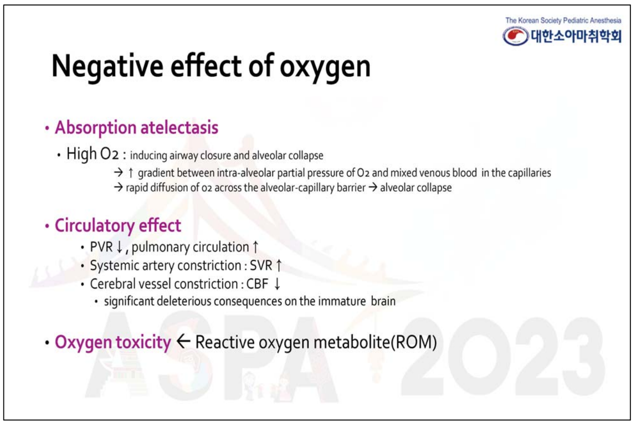
Normal Children
ATELECTASIS
OBSTRUCTION IN BRONCHUS
Remaining air diffuses into tissues and is not replaced
Air flow obstructed
Nonaeration and collapse
lung volume ↓ during induction
→ V/Q mismatch
→ use HIGH FiO2
→ masking of ATELECTASIS; SpO2 ↑
For recognizing intraoperative alveolar closure time,
FiO2 30-35% would be great
Duncan L, Correia M, Mogane P. Children. 2022; 9(9):1416


The Korean Society Pediatric Anesthesia
대한소아마취학회
High inspired oxygen fraction impairs lung volume and ventilation heterogeneity in healthy children: a double-blind randomised controlled trial
Béatrice de la Grandville, Ferenc Petak, Gergely Albu, Sam Bayat, Isabelle Pichon and Walid Habre
The effect of oxygen concentration on atelectasis formation during induction of general anesthesia in children: A prospective randomized controlled trial
Hyun Il Kim | Ji Young Min | Jeong-Rim Lee | Choi Kwan Woong | Matthew R. Cho | Hyo-Jin Byon
• 6-16 years, elective non-abdominal and non-thoracic surgery <200 min, general anesthesia with tracheal intubation
• ASA 1 or 2, BMI <30 kg/m2
• Group
• FiO2 0.8/0.35 group (FiO2=0.8 at induction/emergence; FiO2=0.35 intraoperatively)
• FiO2>0.8 group (Fio2=1.0 at induction/emergence; FiO2=0.8 intraoperatively)
• FiO2>0.8 decreased lung volume in the immediate postoperative period
60% oxygen | 80% oxygen | 100% oxygen | p value
After anesthetic induction 2.0 (1.0-2.5) 2.0 (1.0-2.8) 3.0 (2.0-3.0) .033
At the end of operation 2.0 (1.3-3.8) 3.0 (1.8-3.0) 4.0 (2.0-4.0) .205
Groups compared | p value
60% vs. 80% .4422
60% vs. 100% .0151
80% vs. 100% .0744
Lower FiO2 : atelectasis ↓, keep lung volume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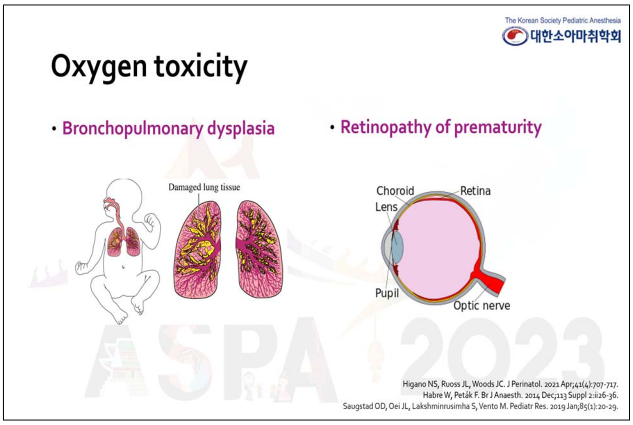
Negative effect of oxygen
• Absorption atelectasis
• High O2 : inducing airway closure and alveolar collapse
→ ↑ gradient between intra-alveolar partial pressure of O2 and mixed venous blood in the capillaries
→ rapid diffusion of o2 across the alveolar-capillary barrier → alveolar collapse
• Circulatory effect
• PVR ↓, pulmonary circulation ↑
• Systemic artery constriction : SVR ↑
• Cerebral vessel constriction : CBF ↓
• significant deleterious consequences on the immature brain
• Oxygen toxicity ← Reactive oxygen metabolite(ROM)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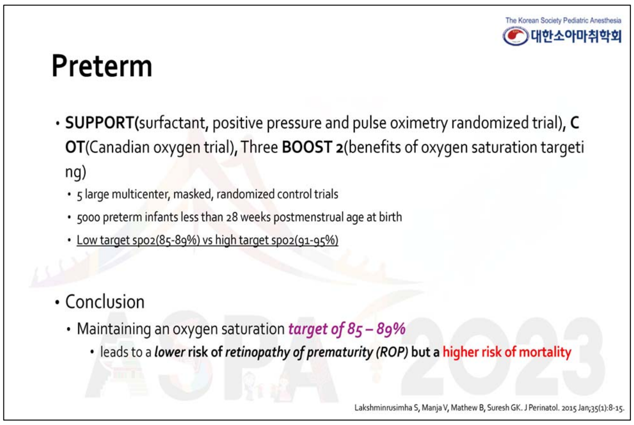
Oxygen toxicity
• Bronchopulmonary dysplasia
• Retinopathy of prematurity
Damaged lung tissue
Choroid
Retina
Lens
Pupil
Optic nerve
Higano NS, Ruoss JL, Woods JC. J Perinatol. 2021 Apr;41(4):707-717.
Habre W, Peták F. Br J Anaesth. 2014 Dec;113 Suppl 2:ii26-36.
Saugstad OD, Oei JL, Lakshminrusimha S, Vento M. Pediatr Res. 2019 Jan;85(1):20-29.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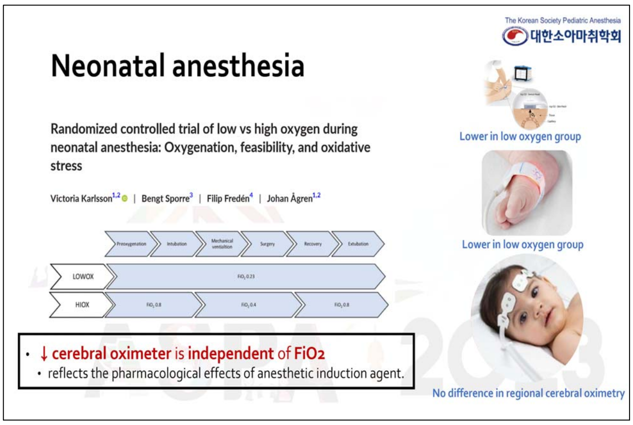
Preterm
• SUPPORT(surfactant, positive pressure and pulse oximetry randomized trial), COT(Canadian oxygen trial), Three BOOST 2(benefits of oxygen saturation targeting)
• 5 large multicenter, masked, randomized control trials
• 5000 preterm infants less than 28 weeks postmenstrual age at birth
• Low target spo2(85-89%) vs high target spo2(91-95%)
• Conclusion
• Maintaining an oxygen saturation target of 85 – 89%
• leads to a lower risk of retinopathy of prematurity (ROP) but a higher risk of mortality
Lakshminrusimha S, Manja V, Mathew B, Suresh GK. J Perinatol. 2015 Jan;35(1):8-15.


The Korean Society Pediatric Anesthesia
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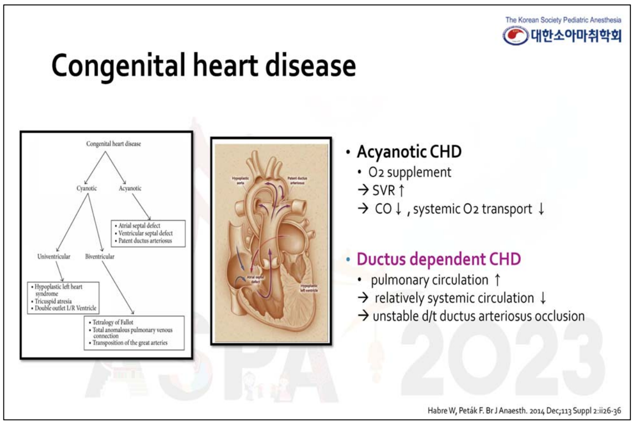
Neonatal anesthesia
Randomized controlled trial of low vs high oxygen during neonatal anesthesia: Oxygenation, feasibility, and oxidative stress
Victoria Karlsson | Bengt Sporre | Filip Fredén | Johan Ågren
Preoxygenation
Intubation
Mechanical ventilation
Surgery
Recovery
Extubation
LOWOX
FiO2 0.23
HIOX
FiO2 0.8
FiO2 0.4
FiO2 0.8
• ↓ cerebral oximeter is independent of FiO2
• reflects the pharmacological effects of anesthetic induction agent.
Lower in low oxygen group
Lower in low oxygen group
No difference in regional cerebral oximetry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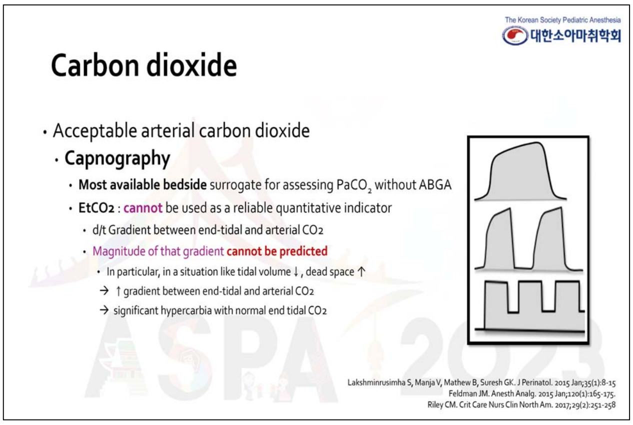
Congenital heart disease
Congenital heart disease
Cyanotic
Acyanotic
• Atrial septal defect
• Ventricular septal defect
• Patent ductus arteriosus
Univentricular
Biventricular
• Hypoplastic left heart syndrome
• Tricuspid atresia
• Double outlet L/R Ventricle
• Tetralogy of Fallot
• Total anomalous pulmonary venous connection
• Transposition of the great arteries
• Acyanotic CHD
• O2 supplement
→ SVR ↑
→ CO ↓, systemic O2 transport ↓
• Ductus dependent CHD
• pulmonary circulation ↑
→ relatively systemic circulation ↓
→ unstable d/t ductus arteriosus occlusion
Habre W, Peták F. Br J Anaesth. 2014 Dec;113 Suppl 2:ii26-36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Carbon dioxide
• Acceptable arterial carbon dioxide
• Capnography
• Most available bedside surrogate for assessing PaCO2 without ABGA
• EtCO2 : cannot be used as a reliable quantitative indicator
• d/t Gradient between end-tidal and arterial CO2
• Magnitude of that gradient cannot be predicted
• In particular, in a situation like tidal volume ↓, dead space ↑
→ ↑ gradient between end-tidal and arterial CO2
→ significant hypercarbia with normal end tidal CO2
Lakshminrusimha S, Manja V, Mathew B, Suresh GK. J Perinatol. 2015 Jan;35(1):8-15
Feldman JM. Anesth Analg. 2015 Jan;120(1):165-175.
Riley CM. Crit Care Nurs Clin North Am. 2017;29(2):251-258

- **Lung-protective ventilation** in small patients
  - Risk of inadequate tidal volume or an unfavorable VD/Vt ratio, **causing a larger than normal difference between Paco2 and end tidal co2**
- Caring for patients with **immature lungs**
  - **Difficult to assess ventilation** definitively **based upon** $EtCO_2$ **alone.**
    - Accepting hypercarbia can be part of the lung protective ventilation strategy.
- When **accurate control of Paco2 is required** (e.g., increased ICP)
  - **Arterial blood gas analysis** is necessary to document effective ventilation

Feldman JM. Anesth Analg. 2015 Jan;120(1):165-175

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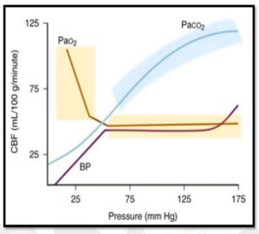
Relationship with cerebral circulation



- The influence on the cerebral circulation : **PaCO2 > PaO2**
- **↓ CBF d/t hyperoxia in children** is **larger** than in adults.

Habre W, Peták F. Br J Anaesth. 2014 Dec;113 Suppl 2:ii26-36
Anesthesia for congenital heartdisease 3rd edition

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Neonate

- In healthy neonates,
  - the **physiological CO2 range** is defined as **35.3–45.0 mmHg.**
- **Hyper- and hypocapnia** can both have **detrimental effects** for newborn infants.

Wong SK, Chim M, Allen J, Butler A, Tyrrell J, Hurley T, McGovern M, Omer M, Lagan N, Meehan J, Cummins EP, Molloy EJ. Carbon dioxide levels in neonates: what are safe parameters? Pediatr Res.

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REVIEW ARTICLE OPEN

Carbon dioxide levels in neonates: what are safe parameters?

Sie Kei Wong[1], M. Chim[1], J. Allen[1,2], A. Butler[1], J. Tyrrell[1], T. Hurley[1], M. McGovern[1], M. Omer[1,3], N. Lagan[1,2], J. Meehan[1,2], E. P. Cummins[4] and E. J. Molloy[1,2,3,5]

	n = 359	(Level 3)		low birth weight infants
	Carlo et al.[28] (2002), n = 220	RCT (Level 3)	$PaCO_2$ < 6.8 kPa (<51.0 mmHg)	Does not decrease mortality and incidence of BPD in extremely low weight infants, however, use of mechanical ventilation at 36 weeks is reduced
	Ambalavanan N et al.,[30] n = 1316	Secondary analysis of a RCT (Level 3)	$PaCO_2$ 6.0–7.3 kPa (45–55 mmHg)	Hypercapnia (higher maximum, average or fluctuation) significantly increases mortality and risk of BPD of extremely low birth weight infants
IVH	Ambalavanan N et al.,[30] n = 1316	Secondary analysis of a RCT (Level 3)	$PaCO_2$ 6.0–7.3 kPa (45–55 mmHg)	Higher maximum $PaCO_2$ is associated with higher risk of IVH and mortality in extremely low birth weight infants independently
	Zayek et al.[28] (2014) n = 580	Retrospective cohort study (Level 4)	pCO_2 < 6.0 kPa (<45.0 mmHg)	May lower the risk of IVH in extremely low birth weight infants
	Vela-Huerta et al.[29] (2009) n = 83	Retrospective case control study (Level 5)	$PaCO_2$ < 7.3 kPa (<45.0 mmHg)	May lower the risk of severe IVH in extremely low birth weight infants

Table 2. Limits of CO_2: hypercapnic, hypocapnic and permissive hypercapnia parameters for term infants (NE and CDH).

Pathology	Citation	Study type	Safe range	Comments
NE	Nadeem et al.[33] (2009), n = 55	Retrospective cohort study (Level 4)	pCO_2 2.6–3.3 kPa (19.5–24.7 mmHg)	No significant association between moderate hypocapnia (2.6–3.3 kPa or 19.5–24.7 mmHg) and hypercapnia (>6.6 kPa or 49.5 mmHg) over the first 3 days after birth and adverse neurodevelopmental outcomes
	Pappas et al.[34] (2011), n = 204	Secondary study RCT (Level 3)	pCO_2 > 2.6–3.3 kPa (>19.5–24.7 mmHg)	Association between poor neurodevelopmental outcomes at 18–22 months of age and both minimum pCO_2 and cumulative 2.6–3.3 kPa (or 19.5–24.7 mmHg) in infants with NE
	Klinger et al.[54] (2005), n = 244	Retrospective cohort study (Level 4)	$PaCO_2$ > 2.6 kPa >19.5 mmHg)	Severe hypocapnia ($PaCO_2$ < 2.6 kPa or <19.5 mmHg) is associated with adverse neurological outcomes (severe CP, etc.) in term infants with post-asphyxial neonatal encephalopathy.
CDH	Abbas PI et al.,[18] n = 74	Retrospective cohort study (Level 4)	$PaCO_2$ 5.2 kPa (39.0 mmHg)	Maintaining initial, best $PaCO_2$ and $PaCO_2$ after resuscitation within physiological range (5.2 kPa or 39.0 mmHg) is associated with improved survival rates
	Bojanic et al.[36] (2015), n = 83	Retrospective cohort study (Level 4)	$PcCO_2$ ≤ 8.7 Pa (≤65.3 mmHg)	Permissive hypercapnia ($PcCO_2$ ≤ 8.7 kPa or ≤65.3 mmHg) is potentially protective

1 kPa = 7.5 mmHg = 7.5torr = 10.2 mmH_2O, *NE* neonatal encephalopathy, *CDH* congenital diaphragmatic hernia.

PVL
Neurodev & CP
1 kPa = 7.5 mmH
cerebral palsy.

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- **Periventricular leukomalacia**: $PaCO_2$ > 35mmHg
- **Neurodevelopmental, cerebral palsy**: 35.3mmHg < $PaCO_2$ < 54.8mmHg
- **Neonatal enterocolitis**: $PaCO_2$ > 24.7mmHg

- **Bronchopulmonary dysplasia** : $PaCO_2$ < 50mmHg
- **Intraventricular hemorrhage** : $PaCO_2$ <57.8-60mmHg
- **Congenital diaphragmatic hernia** : $PaCO_2$ <39mmHg, $PcCO_2$ <65.3mmHg

Wong SK, Chim M, Allen J, Butler A, Tyrrell J, Hurley T, McGovern M, Omer M, Lagan N, Meehan J, Cummins EP, Molloy EJ. Carbon dioxide levels in neonates: what are safe parameters? Pediatr Res.

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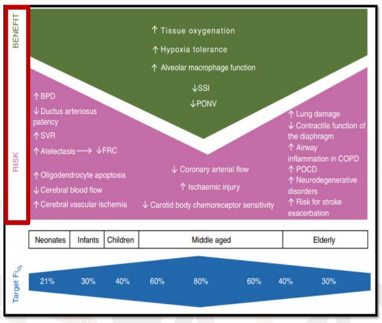

Habre W, Peták F. Br J Anaesth. 2014 Dec;113 Suppl 2:ii26-36

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So, What is optimal O2 and CO2?

- **Avoiding both hypocapnia/hypoxia and hypercapnia/hyperoxia is optimal,** but there is ***not*** a uniform range of optimal CO2/O2.

- *It depends on what you focus on most*
- *Unless the patient's condition is bad, it is better to* ***avoid providing high oxygen***
- *Consider patient's condition*

PEEP and Recruitment, Mode of Ventilation

Pichaya Waitayawinyu

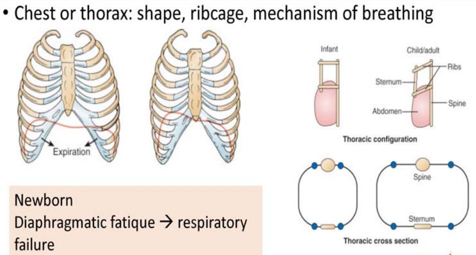
Department of Anesthesiology, Siriraj Hospital, Mahidol University, Thailand

Outline

- Children's lungs – what differ from adults'
- Atelectasis during general anesthesia
- PEEP and Lung recruitment – role and how to perform intraoperatively
- Lung protective ventilation
- Mode of intraoperative mechanical ventilation in pediatric patients

Anatomical Differences

- Chest or thorax: shape, ribcage, mechanism of breathing



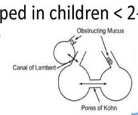
Newborn
Diaphragmatic fatique → respiratory failure

Anatomical Differences

- Breathing pattern – preferential nasal breathing, diaphragmatic breather, poor developed intercostal muscles and abdominal muscle, high RR due to limit chest expansion
- Diaphragm – angle of insertion more horizontal, infants have less high endurance muscle fibers
- Large internal organs
- Airway diameter – short trachea, small airway diameter, right bronchus less angled, airway swelling produces high resistance

Anatomical Differences

- Bronchial walls – more cartilage & connective tissue, less muscle
- Surfactant – reduces surface tension, secreted from 23 week GA, surge at 30-34 week GA
- Alveoli – very few, small alveoli at birth (→ increases in numbers and sizes rapidly in 2 years), susceptible to collapse and atelectasis
- Collateral ventilation – poorly developed in children < 2-3 years → more susceptible to alveolar collapse



Physiologic Differences

- Lung compliance – newborn & infant < adult's, child ~ adult's
  - Compliant chest wall
  - Need for adequate pressure to open up the alveoli with a risk of volutrauma and barotrauma
- Airway resistance - newborn ↑↑ and decreases to adult values at 8 years old

Physiologic Differences

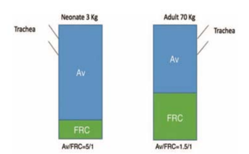


Figure 1. Functional residual capacity. Av=alveolar ventilation; FRC=Functional residual capacity; Av/FRC=alveolar ventilation/Functional residual capacity.
Source: Authors.

- FRC - proportionally less than in the adult and than the pulmonary capacity
- Normal glottic closure at end exhalation is prevented by ETT – a minimal PEEP maintain physiologic FRC in pediatric patients

Rivera-Tocancipa D, Diaz-Sanchez E. How to ventilate the anesthetized child with the modern anesthesia machines? Rev Colomb Anestesiol 2018; 46:Supp

Physiologic Differences

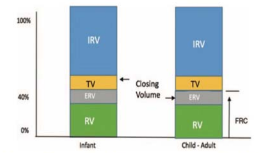


Figure 2. Closing volume. ERV = expiratory reserve volume; RV = residual volumen; FRC = functional residual capacity; IRV = inspiratory reserve volume; TV = tidal volume.
Source: Authors.

- Closing volume - proportionally larger than in the adult and exceeds the FRC under general anesthesia

Rivera-Tocancipa D, Diaz-Sanchez E. How to ventilate the anesthetized child with the modern anesthesia machines? Rev Colomb Anestesiol 2018; 46:Supp

Physiology of Atelectasis

- Airway collapse begins quickly following induction of anesthesia
- Mostly affects the dependent areas of the lungs where the transpulmonary pressure is lowest
- Loss of muscle tone → FRC ⬇ →small airway closure
- Compression of lung tissue by transmitting intra-abdominal pressure
- High FiO_2 use at induction promotes atelectasis
- Atelectasis → intra-pulmonary shunt ⬆ → hypoxemia
- Atelectasis – also place the patient at risk of developing ventilator-associated lung injury

Trachsel D, Svendsen J, Erb TO, von Ungern-Sternberg. Effects of anaesthesia on paediatric lung function. Br J Anaes 2016. 117(2):151-63

Physiology of Atelectasis

- Anesthetic agent use – atelectasis occurs with both intravenous and inhalational general anesthesia
- Light sedation is associated with less atelectasis compared with general anesthesia
- Muscle relaxant reduces FRC and impair ventilation distribution in children (FRC decreases 45% in infants vs 10% in preschool-age children)
- Ketamine has less impact to muscle activity compared with propofol

→ FRC 20% higher in preschool-age children

Bruins S, Sommerfield D, Powers N, et al. Atelectasis and lung recruitment in pediatric anesthesia: an educational review. Ped Anesth 2022;32:321-329

Recruitment maneuver and PEEP improve ventilation/perfusion mismatch

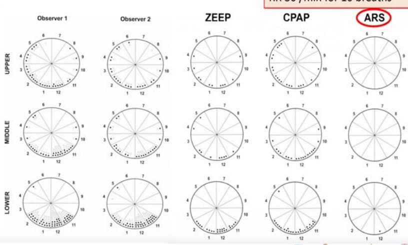
Anesthesiology 2003; 98:14–22 © 2003 American Society of Anesthesiologists, Inc. Lippincott Williams & Wilkins, Inc.

Effects of Recruitment Maneuver on Atelectasis in Anesthetized Children

Gerardo Tusman, M.D., Stephan H. Böhm, M.D.,† Alejandro Tempra, M.D.,‡ Fernando Melkun, M.D.,* Eduardo García, M.D.,‡ Elsio Turchetto, M.D.,§ Paul G. H. Mulder, M.S., Ph.D.,‖ Burkhard Lachmann, M.D., Ph.D.#*

CPAP 5 → 10 → 15 every 4 breaths
Then bring PIP up to 40 cmH_2O
RR 30 /min for 10 breaths

- 24 children (6 mo-6 y) for cranial MRI
- Use MRI imaging for measuring atelectasis volume during anesthesia
- Randomized to ZEEP, CPAP 5, ARS group
- ARS: Alveolar recruitment performed after induction of GA then keep PEEP at 5 through out



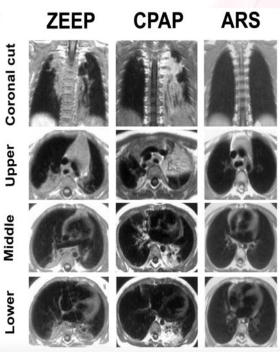


Fig. 3. Nuclear magnetic resonance images of representative patients for each of the three treatment groups. (*Left*) ZEEP = zero end-expiratory pressure; (*middle*) PEEP = positive end-expiratory pressure of 5 cm H_2O; (*right*) ARS = alveolar recruitment strategy with images taken at a PEEP of 5 cm H_2O. The top of each column shows a coronal view, followed by an upper, a middle, and a lower axial cut through the thorax (for details, see text). In children of the ZEEP group, atelectasis volume was 18 ml in the right lung and 16 ml in the left lung. In children of the CPAP group, atelectasis volume was 10 ml in the right lung and 33 ml in the left lung. The ARS group showed no atelectasis.

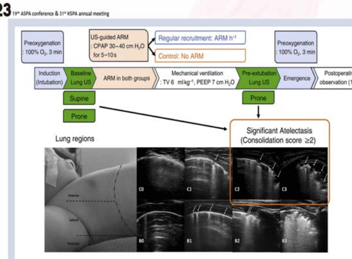


Fig 1. Study protocol. The study protocol, lung ultrasound method by Acosta and colleagues,[13] and the degree of consolidation and B-lines by lung ultrasound (US) described by Song and colleagues.[3] C0, no consolidation; C1, minimal juxtapleural consolidations; C2, small-sized consolidations; and C3, large-sized consolidations. B0, fewer than three isolated B-lines; B1, multiple well-defined B-lines; B2, multiple coalescent B-lines; and B3, white lung. ARM, alveolar recruitment manoeuvre; TV, tidal volume.

Jang YE, Ji SH, Kim EH, at al. Effect of regular alveolar recruitment on intraoperative atelectasis in paediatric patients ventilated in the prone position: a randomized control trial. Br J Anaesth 2020; 124(5): 648-55.

EJA

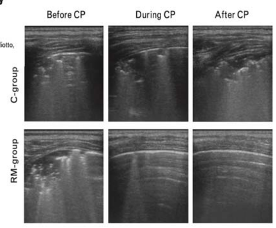
Eur J Anaesthesiol 2018; **35**:573–580

ORIGINAL ARTICLE

Lung recruitment prevents collapse during laparoscopy in children

A randomised controlled trial

Cecilia M. Acosta, Tomás Sara, Martín Carpinella, Giovanni Volpicelli, Lila Ricci, Sergio Poliotto, Diego Abrego, Sergio Gonorazky, Stephan H. Böhm and Gerardo Tusman



Lung ultrasound images of one representative patient per group during the protocol. C-group, control group; CP, capnoperitoneum; RM-group, lung recruitment manoeuvre group.

Recruitment maneuver regimens

- Sustained application of positive airway pressure up to a set of minimum of 40 cmH_2O for 10-30 sec before returning to baseline
- Varying airway pressures during the respiratory cycle by gradually and stepwise increasing PEEP (to approximately 15-20 cmH_2O) → increase in tidal volume to a maximum PIP 40 cmH_2O → gradual lowering of PEEP to level required to prevent de-recruitment

Bruins S, Sommerfield D, Powers N, et al. Atelectasis and lung recruitment in pediatric anesthesia: an educational review. Ped Anesth 2022;32:321-329

TABLE 2 Strategies to reduce atelectasis in anesthetized children

Strategies to reduce atelectasis
• Continuous positive airway pressure (30–40 cmH_2O) for 5–10 s
• Multiple prolonged breaths of 30–40 cmH_2O of continuous pressure over PEEP
• Stepwise increase in airway pressure to max 40 cmH_2O under LUS guidance
• PCM with constant driving pressure of 15 cmH_2O and stepwise increase by 5 cmH_2O until 30–40 cmH_2O
• PEEP >4 cmH_2O
• Postural RM, particularly following thoracotomy
• Avoiding high FiO_2
• RM with cuffed ETT superior to SGA/face-mask
• Avoidance of neuromuscular blockade

Abbreviations: LUS, lung ultrasound; PCM, Pressure Controlled Mode; PEEP, positive end-expiratory pressure; RM, recruitment maneuver; SGA, supraglottic airway., ETT endotracheal tube.

Bruins S, Sommerfield D, Powers N, et al. Atelectasis and lung recruitment in pediatric anesthesia: an educational review. Ped Anesth 2022;32:321-329

What is Lung Protective Ventilation? and Why Should We Care?

- Mechanical ventilation strategies aimed at minimizing lung injury
- Avoidance of volutrauma and atelectrauma
- Most data from adults' studies
- Lower mortality rates in adult patients ventilated with a tidal volume (Vt) of 6mL/kg ideal body weight (IBW) and plateau pressures (Pplat) <30cmH_2O compared to Vt of 12mL/kg IBW and Pplat <50 cmH_2O (ARDSNet)
- In nonobese adult patients undergoing open abdominal surgery, ventilation of Vt 8 ml/kg with PEEP of 12 cmH_2O combined with recruitment maneuvers was compared with PEEP of 2 cmH_2O without recruitment maneuvers No different in postoperative pulmonary complication

Kilpatrick B, Slinger P. Lung protective strategies in anaesthesia. Br J Aaes 2010. 105(51):i108-16
ARDSNet trial, PALIVE study, PROVHILO study
Heath C, Hauser N. Is there a role for lung-protective ventilation in healthy children?. Ped Anesth 2022. 32(2);278-85.

What is Lung Protective Ventilation? and Why Should We Care?

- Concerns with the use of low Vt - increased risk of atelectasis, development of hypercapnia, reduction in respiratory compliance.
- Specifically, in the pediatric context, lowering Vt is associated with concerns about increased dead space and hypercapnia.
- In simulated models of pediatric acute respiratory distress (PARDS) patients ventilated with Vt of 10 ml/kg, no compromise in gas exchange was demonstrated

Recommendations for Lung Protective Strategies in Healthy Pediatric Patients

1. Target Vt 6-10 mL/kg IBW, avoiding Vt > 10 mL/kg
2. Limit PIP < 30 cmH_2O and delta pressure < 10 cmH_2O. Monitor variations in Vt carefully to avoid volutrauma
3. PEEP remains an important component of LPV but the optimal level of PEEP for pediatric patients is unknown. Suggest PEEP range of 4-8 cmH_2O
4. Recruitment maneuver

Heath C, Hauser N. Is there a role for lung-protective ventilation in healthy children?. Ped Anesth 2022. 32(2);278-85.

Recommendations for Lung Protective Strategies in Healthy Pediatric Patients (cont)

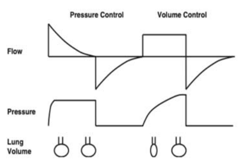
5. Avoid FiO_2 of 1.0 unless a clinical emergency occurs
6. Recruitment advised to maintain FRC – suggest either sustained inflation of 30 cmH_2O for 10-30 sec or an incremental increase in PEEP based on individual patient needs

Heath C, Hauser N. Is there a role for lung-protective ventilation in healthy children?. Ped Anesth 2022. 32(2);278-85.

Mode of Ventilation

Pressure-controlled Ventilation

- Square wave pressure waveform provides the maximum inspiratory pressure for the entire i-time favoring lung recruitment
- Maximum volume of ventilator is available to develop the rest pressure → the desired tidal volume can be delivered even small leak presents
- Provide rapid rate, high inflating pressure – suitable for patients with severe lung pathology
- Maximum PIP is limited → prevent barotrauma



Set – inspire pressure, i-time, RR

Initial settings for pressure-controlled mechanical ventilator in children

	Infant (<1 year of age)	Toddler/Child (1-12 year)	Adolescent (>12 year)
PIP (cmH_2O)	16-25		
PEEP (cmH_2O)	3-7		
Rate (breaths/min)	20-30	15-25	12-20
Pressure support (cmH_2O)	Minimum 6-10		
Peak inspiratory flow (L/min)	Adjust to desired inspiratory time		
Inspiratory time (sec) Targeted, based upon changes to inspiratory flow	0.4-0.6	0.7-0.9	0.9-1.2
FiO_2	Start with 1.0 rapidly wean to ≤ 0.6		
Flow trigger (L/min)	0.25-0.5	0.8-2	0.8-2
Pressure support cycle	10-25% of peak flow rate		

Volume- controlled Ventilation

Set – tidal volume, i-time or I:E ratio, RR

- Square wave flow waveform, with flow rate determined by the ration of the set tidal volume to the i-time
- Ensure tidal volume to be delivered by the ventilator
- Tidal volume is delivered regardless of PIP -> risk of barotrauma (stop when maximum pressure limit is reached)
- Risk of losses from the ETT leak

Initial settings for volume-controlled mechanical ventilator in children

	Infant (<1 year of age)	Toddler/Child (1-12 year)	Adolescent (>12 year)
Tidal volume (mL)	5-8 mL/kg		
Rate (breaths/min)	20-30	15-25	12-20
PEEP (cmH_2O)	3-7		
Pressure support (cmH_2O)	Minimum 6-10		
Peak inspiratory flow (L/min)	Adjust to desired inspiratory time		
Inspiratory time (sec) Targeted, based upon changes to inspiratory flow	0.4-0.6	0.7-0.9	0.9-1.2
FiO_2	Start with 1.0 rapidly wean to ≤ 0.6		
Flow trigger (L/min)	0.25-0.5	0.8-2	0.8-2
Pressure support cycle	10-25% of peak flow rate		

Dual Ventilation

- Ensure accurate tidal volume, cycle after cycle, with a limited maximum pressure
- PCV with volume guaranteed (PVC-PG)
- Convenient for frequent and broad airway pressure changes occur; laparoscopic, thoracoscopic surgeries

Pressure Support Ventilation

- Patient initiates spontaneous breathe
- Reduce work of breathing imposed by endotracheal tube or LMA
- Need to keep PCO_2 level to maintain spontaneous breathing
- Combined SIMV and PSV to insure minute ventilation
- Potential advantages:
  - Facilitating emergence of anaesthesia
  - Improved hemodynamics due to less positive pressure needed
  - Assessing depth of anesthesia
  - Titration of opioid analgesia

Synchronized Intermittent Mandatory Ventilation

- Improve the patient-ventilator relationship
- SIMV-Pressure Control (PC) or SIMV-Volume Control (VC)
- Determine patient's 'trigger flow' in order for the ventilator to allow and assist spontaneous ventilation

To Protect the Lungs: keep an eye on

- Impact of breathing systems used for manual ventilation – use modified Jackson Rees T-piece with caution (inexperienced use)
- Impact of extubation – FRC loss, consider put non-invasive ventilation immediately in high risk patient
- Impact of CPB and cardiothoracic surgery – FRC reduction during open chest and CPB

Trachsel D, Svendsen J, Erb TO, von Ungern-Sternberg. Effects of anaesthesia on paediatric lung function. Br J Anaes 2016. 117(2):151-63

Dead Space and the Pediatric Patient

- Dead space = any portion of the breathing circuits or lungs in which there is bidirectional gas flow without gas exchange (include device that provide gas sampling)

V_D/V_T ratio increases –> exponential increases in $PaCO_2$ level

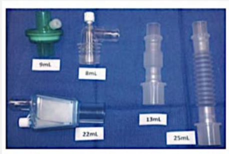
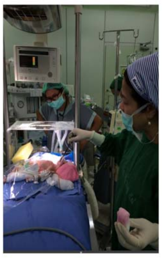
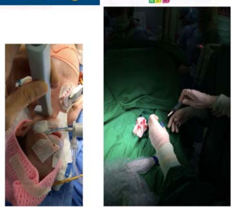


Figure 4. Typical apparatus added to the breathing circuit with internal volumes noted. Dead space volume added to the circuit can range from 9 mL for the smallest heat and moisture exchanger (HME) pictured to 55 mL for the combination of elbow, large HME, and expanded flexible extension. (From Pearsall M, Feldman JM, When does apparatus dead space matter for the pediatric patient? Anesth Analg 2014;118:776–80.)

Ventilation Monitoring

Clinical signs:
- Respiratory rate
- Physical examination – chest movement, synchrony, percussion, breath sounds
- Movement of reservoir bag

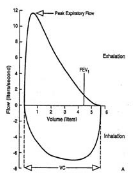
Monitoring to Achieve Optimal Ventilation

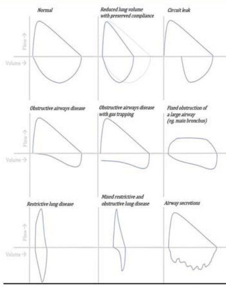
- Gold standard – Arterial blood gas analysis
- Standard
  - Oxygenation: pulse oximeters
  - Ventilation: $ETCO_2$
  - Respiratory mechanics: loops and scalars

Continuous vigilance of trained anesthesia personnel

Ventilation Monitoring in the Modern Machines Spirometry:

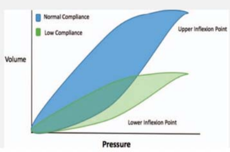
- Flow-volume loop

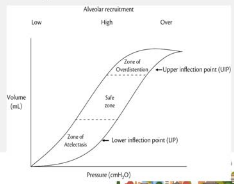




Ventilation Monitoring in the Modern Machines Spirometry:

- Pressure-volume loop
- Identify the pulmonary compliance – flattened curve -> decrease pulmonary compliance
- Determine ideal PEEP at lower inflexion point

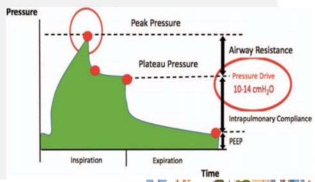




Ventilation Monitoring in the Modern Machines Pressure-time curve:

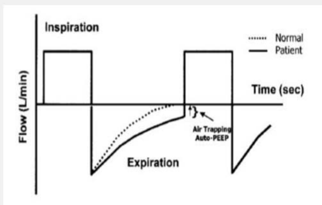
- Airway resistance – approximately 5 cmH_2O, if > 8-10 cmH_2O = high endotracheal resistance (tube kink, partial airway obstruction from secretion, very small tube)
- High PIP with normal airway resistance = high Pplat -> changes in pulmonary compliance
- Pressure drive (driving pressure) ideally < 10 cmH_2O,

should not > 14 → raise PEEP level



Ventilation Monitoring in the Modern Machines Flow-time curve:

- Determine I:E ratio



Goals for an Optimal Ventilation

- Optimal PaO_2 at the lowest inspired oxygen concentration
  - Recruitment maneuver in case of using FiO_2 < 0.25
- An acceptable $PaCO_2$
  - $ETCO_2$ less predictable in small tidal volume or increased dead space
- The desired tidal volume at the least inspiratory pressure
  - Interprete expired tidal volume with caution
  - Use pressure-volume (PV) loop as a guide
  - Add PEEP or recruitment maneuver

Be acquainted with your anesthesia machine

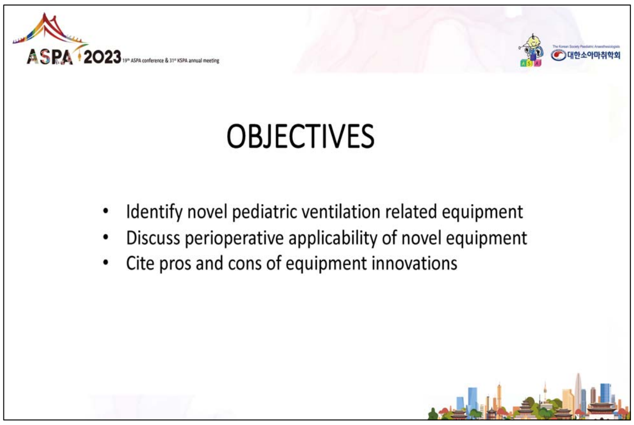
Summary

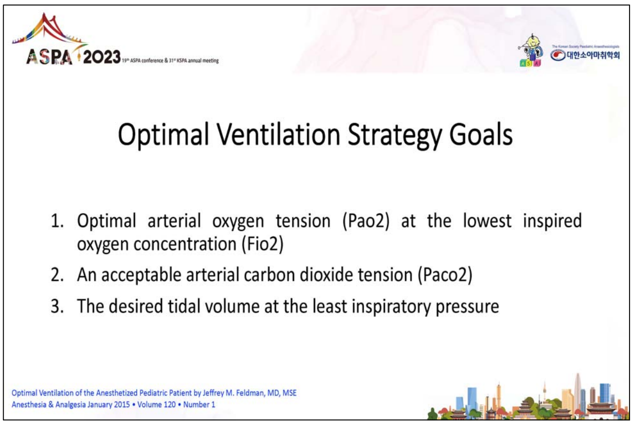
- Atelectasis develop easily in children especially during general anesthesia
- PEEP and lung recruitment shoud be performed to prevent atelectasis
- Lung protective ventilation is suggeted
- The ideal mode of intraoperative mechanical ventilation in pediatric patients is not definite.

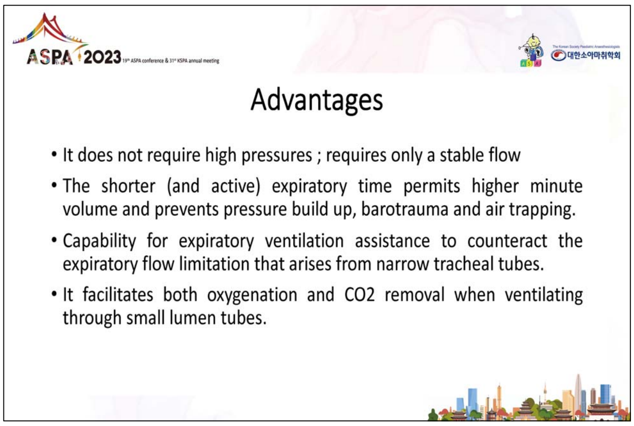
Inhale the Future Exhale the Past Smart Choice of Ventilation Equipment

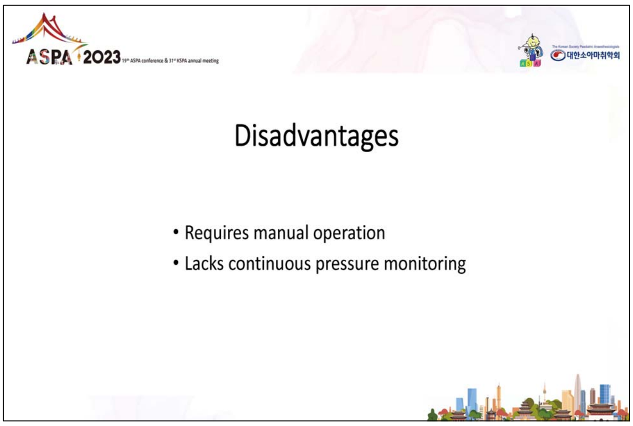
Joy E. Luat-Inciong

St. Luke's Medical Center, Philippines





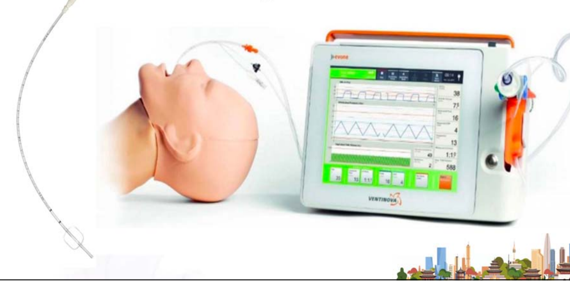




Flow Controlled Ventilation

- energy dissipation that occurs during intermittent positive-pressure ventilation is one of the contributors to ventilator induced lung injury (VILI)
- to reduce energy dissipation, the flow must be held constant with an inspiratory to expiratory ratio (I:E) close to 1:1.

Evone® Flow Controlled Ventilator using Tritube®

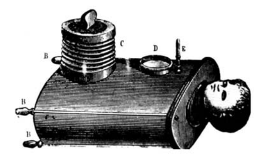


Pros & Cons

- The use of relatively low flow rates leads to improved distribution of lung aeration and improved gas exchange compared to conventional ventilation.
- Possibility to ventilate through very narrow endotracheal tubes

- Can only be used with total intravenous anesthesia since vaporizers cannot be included in the breathing circuit.
- Lacks adaptive ventilation modes and the possibility to be triggered by the patient
- Only recommended for use with an ideal body weight of over 40 kg

Negative Pressure Ventilation



Negative Pressure Ventilation

- benefits cardiac patients by improving hemodynamics
- wean from positive-pressure ventilation or combined with it
- bridge therapy until intubation or lung transplantation is available
- used to avoid intubation in selected patients
- could be involved in physiotherapy, home care, or palliative care with better quality of end-life

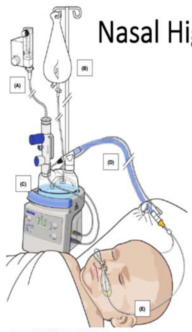
- need to develop standardized ventilation strategies and protocols based on prospective and controlled studies
- determine indications and contraindications, and specific target populations

PeDI R

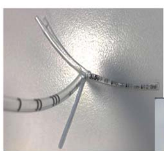
Difficult Airway Bundle Checklist

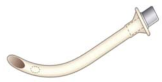
PEdiatric DIfficult Intubation Registry Group

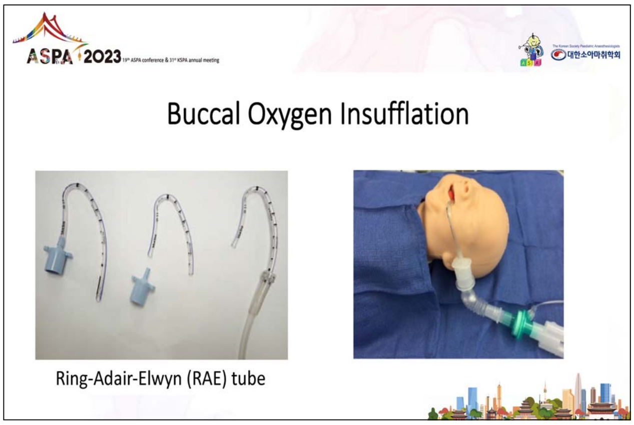
Nasal High-Flow Oxygen

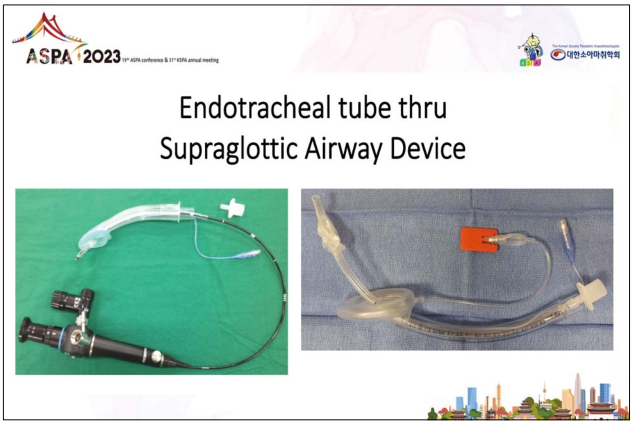


Modified Nasal Trumpet






ASPA 2023
Buccal Oxygen Insufflation
Ring-Adair-Elwyn (RAE) tube


ASPA 2023
Endotracheal tube thru
Supraglottic Airway Device


ASPA 2023
cap-ONE® mask


ASPA 2023
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Normal Breath sound
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2020-05-15 09:38:14
PAO
PAO
13
00:01:00
2020-12-16 08:18:58
Apnea
AccurSound Electronic Stethoscope
(Airmod)

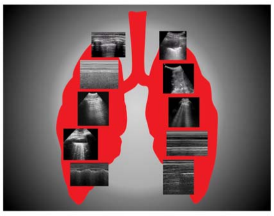
How to Optimize Our Children's Intraoperative Ventilation Care with POCUS

Ayse Cigdem Tutuncu

IU-Cerrahpasa University, Medicine School of Cerrahpasa, Türkiye

Learning objectives

- Intraoperative ultrasound assesment and normal ultrasound findings
- The use of ultrasound as a tool for PEEP titration intraoperatively
- Ultrasound guided recruitment maneuver and detection of alveolar overdistension



Q 1; *How to optimize our children's intraoperative ventilation care?*

The ultimate goal of MV;

- Maintain adequate gas exchange in the alveoli.
- Prevent alveolar collapse
- To induce alveolar opening,
- To avoid lung injury

Q 2; How do we reach this goal ?

Optimal – FiO2, PEEP, Tidal volume, Recruitment maneuver

Avoidance of the lung injury !

Lung protective ventilation strategies

2000

Low tidal volume
Low plateau pressure
High PEEP 'open lung' approach
Low driving pressure

Low ventilation power
Cumulative injuries strain

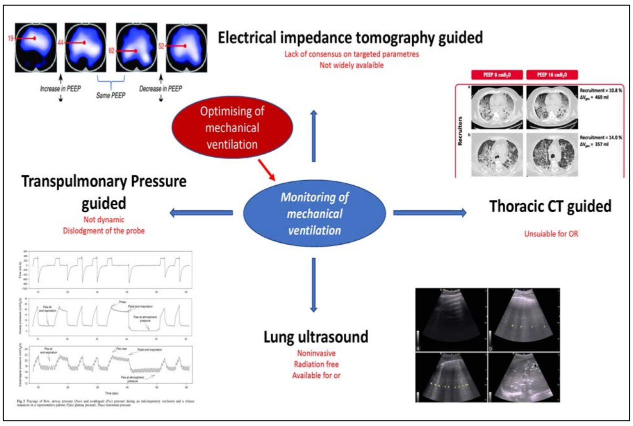
2023

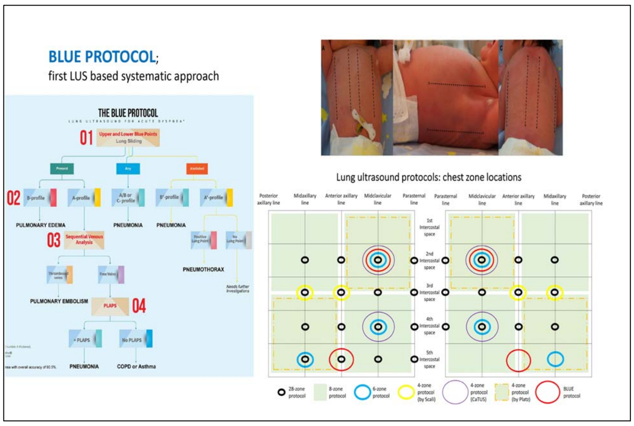
Limit tidal volume to < 7 ml/kg in the OR | Limit tidal volumes to 4-6 ml/kg in the ICU, particularly with ARDS

limited data in children

Prevent atelectasis by utilizing at least 5 cm H_2O PEEP | Use as low an FiO_2 as possible to prevent oxygen toxicity

Best Practice & Research Clinical Anaesthesiology 2015





Study	Clinical Condition/Setting	Diagnostic Accuracy	Comments
Ueda et al[2]	Initial intraoperative assessment of pneumothorax	Case reports: elective laparoscopic procedure/traumatic aortic dissection. Both cases of lung ultrasound provided timely diagnosis	Not mentioned CT as gold standard for diagnostic accuracy; lung ultrasound can be an important part of high-quality anesthesia care
Juang et al[11]	Intraoperative radiological assessment of pleural effusion	Two cases of massive pleural effusion that were only recognized after induction of anesthesia in living donor liver transplantation	Lack of utilization of lung ultrasound having higher diagnostic accuracy and availability in the operating room setting
Chou et al[16]	Detection of esophageal intubation. Twelve eligible studies involving adult patients and cadaveric models were identified from 1488 references	Ultrasonography had pooled sensitivity of 93% (95% CI, .86–.96) and a specificity of 97% (95% CI, 0.95–.98). The area under the summary ROC curve was 0.97 (95% CI, 0.95–.98)	Summary of evidence for high diagnostic value of ultrasonography for esophageal intubation
Alrajab et al[17]	Systematic review of 601 articles with the inclusion of 13 articles for a meta-analysis review. The aim is to evaluate the diagnostic accuracy of pleural ultrasonography in comparison with CXR for the diagnosis of pneumothorax	Lung US had a sensitivity of 78.6% (95% CI, 68.1–98.1) and a specificity of 98.4% (95% CI, 97.3–99.5). CXR had a pooled sensitivity of 39.8% (95% CI, 29.4–50.3) and a specificity of 99.3% (95% CI, 98.4–100.0)	Lung US is more accurate than CXR for detection of pneumothorax
Al Deeb et al[6]	Systematic review of 168 articles with the inclusion of 7 articles for a meta-analysis review. The aim is to determine the accuracy of US using B lines in diagnosing ACPE	The sensitivity of US using B lines to diagnose ACPE was 94.1% (95% CI, 81.3–98.3) and the specificity was 92.4% (95% CI, 84.2–96.4)	The results of this meta-analysis suggest that POC US using B lines may aid clinicians in the diagnosis of ACPE

LUSA-empowered evaluation of intraoperative/perioperative hypoxemia (Spo_2 < 94%)	LUSA Pulmonary edema: bilateral diffuse, homogenous "B" pattern *Pneumothorax:* absent lung sliding, presence of "lung point," absent "B" pattern Pleural effusion: anechoic lung base-diaphragmatic interface Consolidation: heterogeneous hypoechoic visible lung/focal "B" pattern—(atelectasis or pneumonia) Impending major atelectasis: absent lung sliding, presence of "lung pulse" Derecruited dorsal areas: LUSA, dorsal "B pattern"	LUSA (as in "Preinduction Evaluation in Unplanned Anesthesia") consistent with: Pulmonary edema Pneumothorax Pleural effusion Consolidation Impending major atelectasis/endobronchial intubation: absent lung sliding, presence of "lung pulse" Derecruited dorsal areas Aspiration, pneumonitis: unilateral or bilateral, heterogeneous "B" pattern

LUNG POCUS;

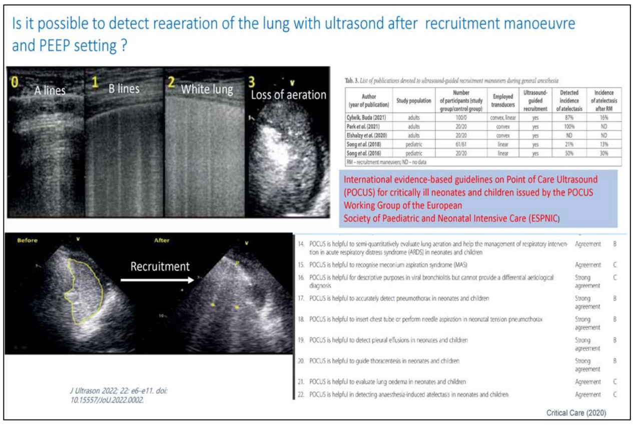
Consolidation

Pneumothorax

Pleural effusion

Pulmonary edeoma

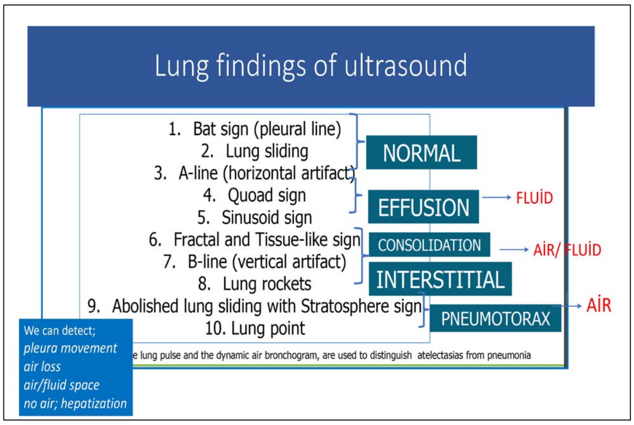
Atelectasis; USG guided RM

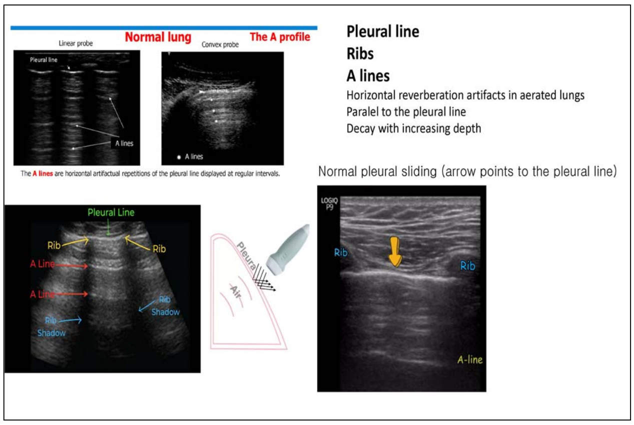


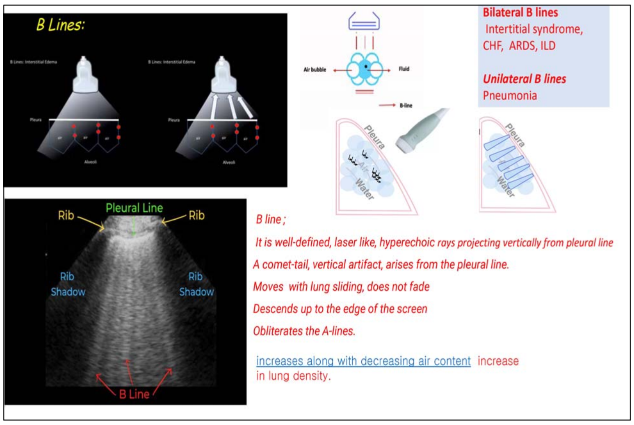
Sensivity specificity of lung POCUS ?

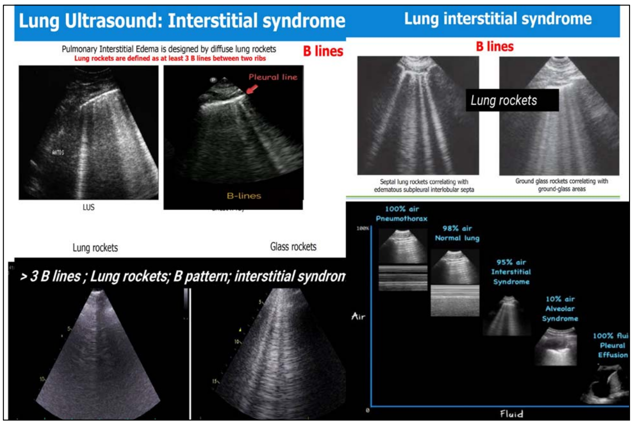
	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Pleural Effusion	94	97	95	90
Alveolar Consolidation *(Pneumonia)*	90	98	88	95
Interstitial Syndrome *(CHF, ARDS)*	93	93	87	99
Complete Pneumothorax	100	96	100	98
Occult Pneumothorax	79	100	89	99
AECOPD	89	97	93	95
Pulmonary Embolism	81	99	94	98

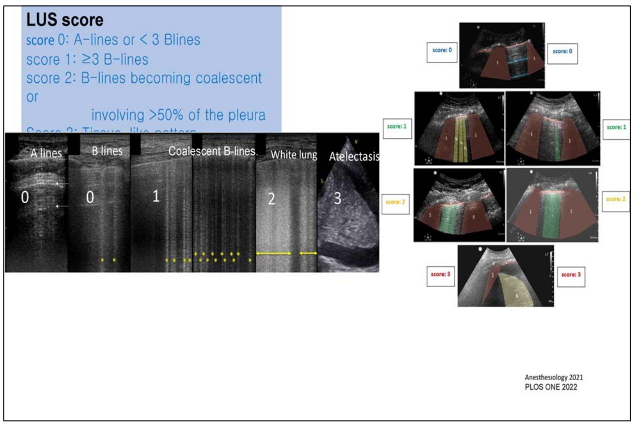
Anesth Analg 2017;124:494–504
Ann int care 2004

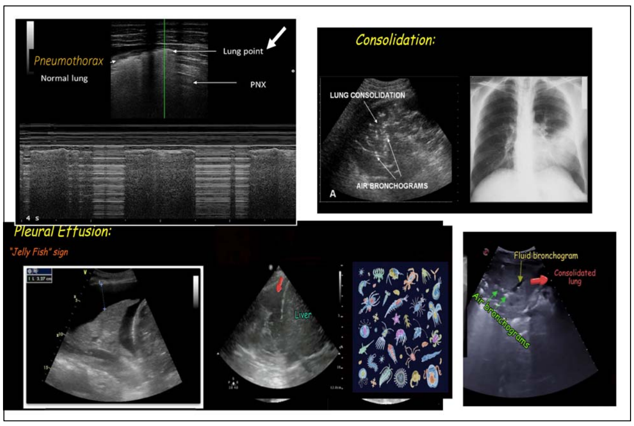




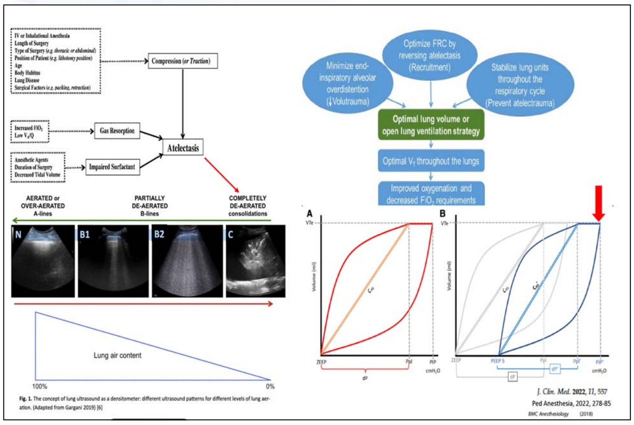


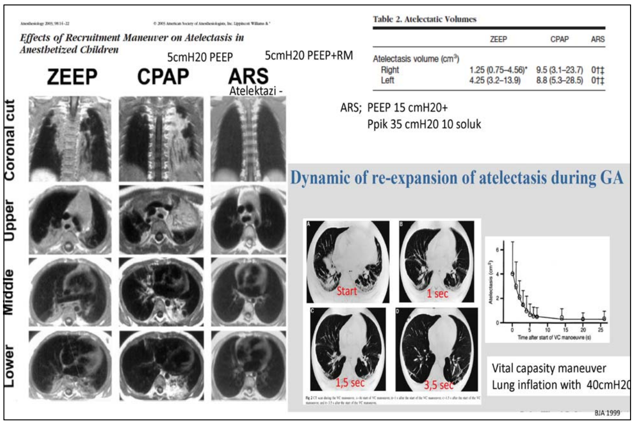


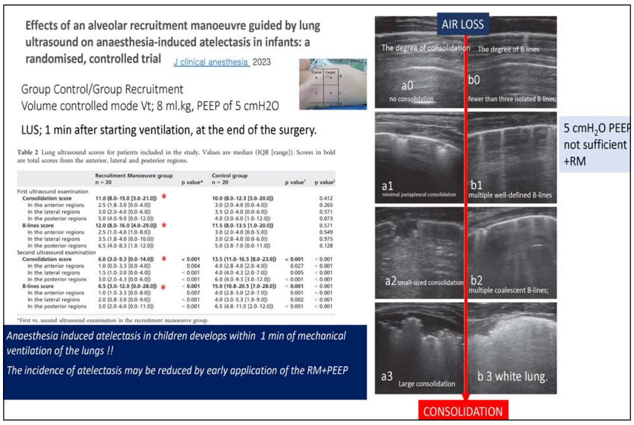


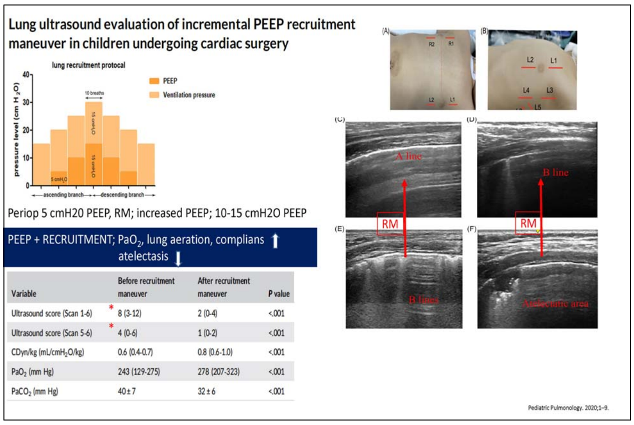


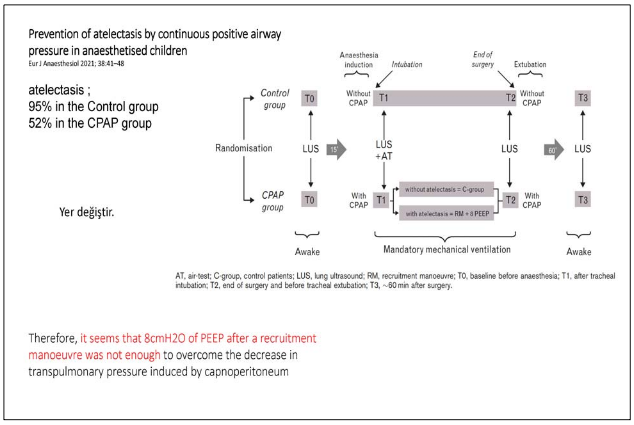
Ayse Cigdem Tutuncu: How to Optimize Our Children's Intraoperative Ventilation Care with POCUS

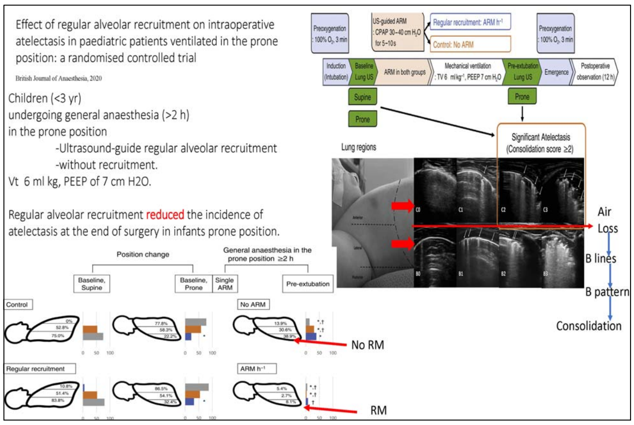


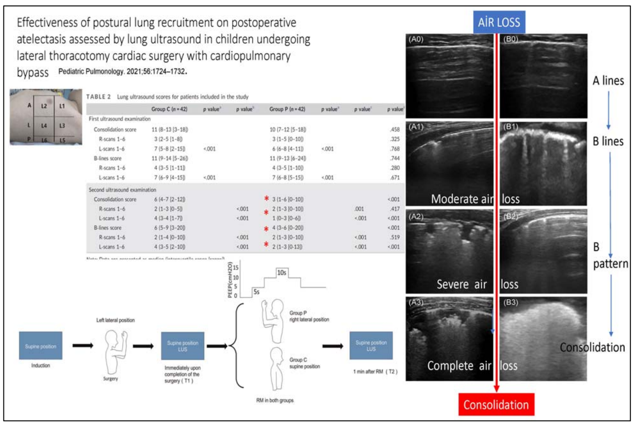


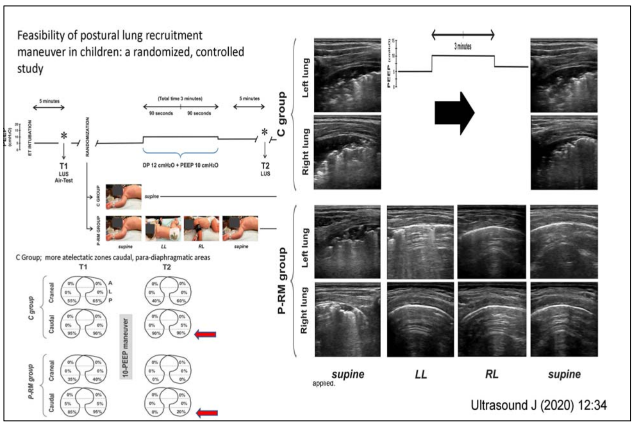


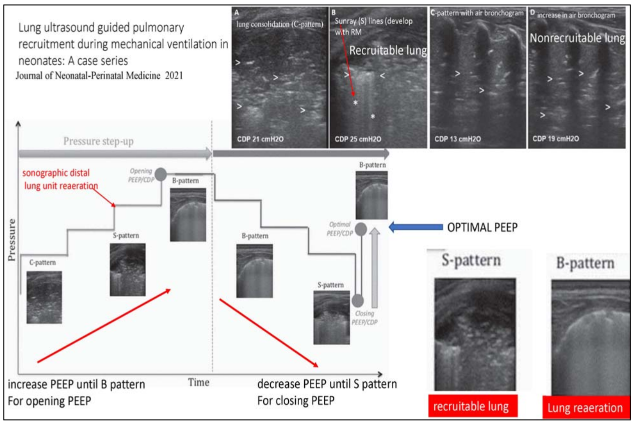


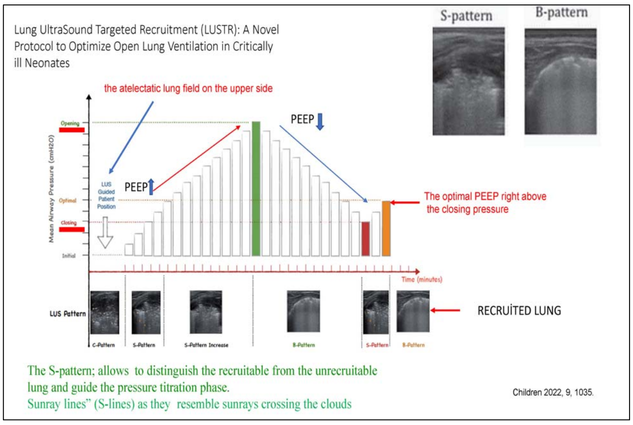


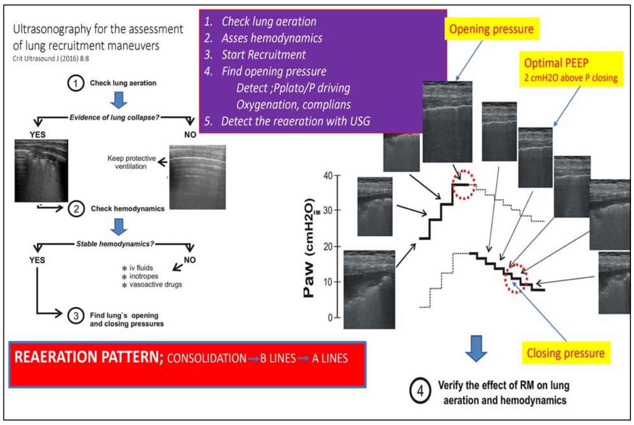


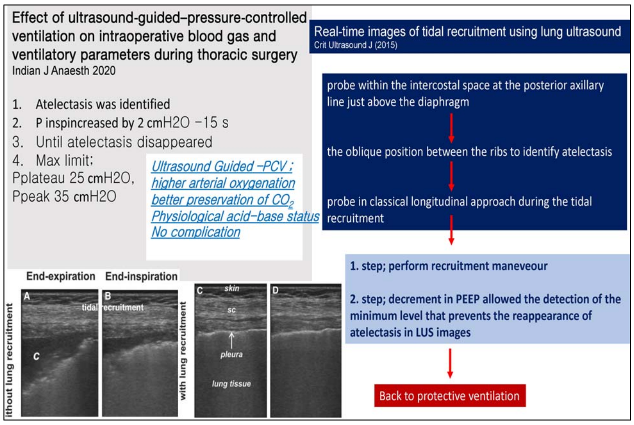


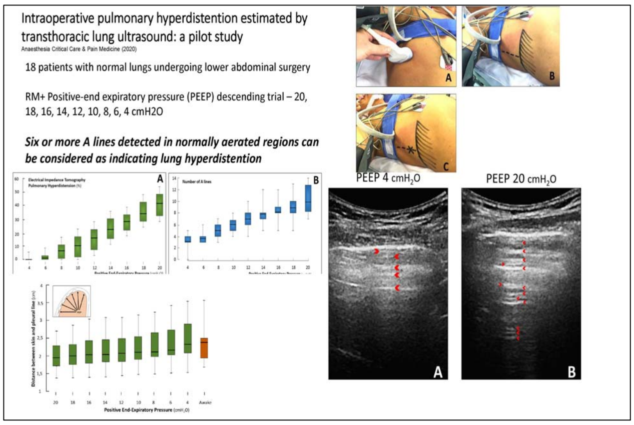


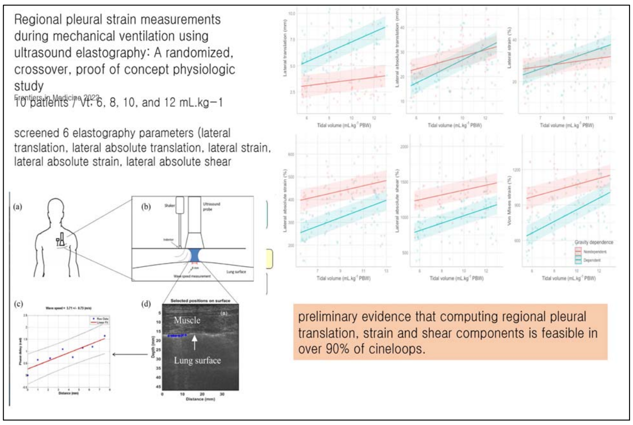

Lung ultrasound guided pulmonary recruitment during mechanical ventilation in neonates: A case series
Journal of Neonatal-Perinatal Medicine 2021
lung consolidation (C-pattern)
Sunray (S) lines (develop with RM
Recruitable lung
C-pattern with air bronchogram
increase in air bronchogram
Nonrecruitable lung
CDP 21 cmH2O
CDP 25 cmH2O
CDP 13 cmH2O
CDP 19 cmH2O
Pressure step-up
sonographic distal lung unit reaeration
Opening PEEP/CDP
B-pattern
S-pattern
C-pattern
Pressure
Optimal PEEP/CDP
Closing PEEP/CDP
OPTIMAL PEEP
S-pattern
B-pattern
Time
increase PEEP until B pattern
For opening PEEP
decrease PEEP until S pattern
For closing PEEP
recruitable lung
Lung reaeration

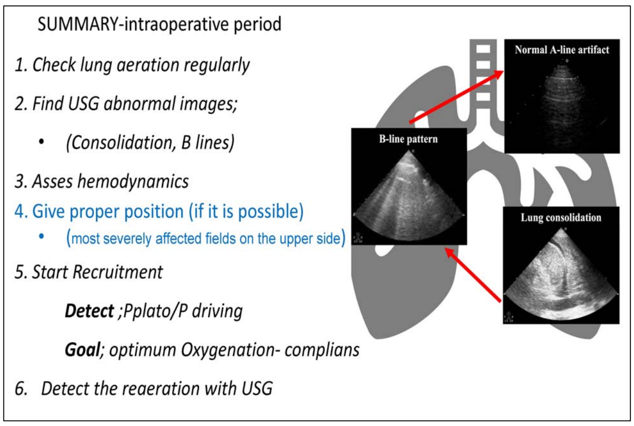

Lung UltraSound Targeted Recruitment (LUSTR): A Novel Protocol to Optimize Open Lung Ventilation in Critically ill Neonates
S-pattern
B-pattern
the atelectatic lung field on the upper side
PEEP
Opening
Optimal
Closing
Initial
Mean Airway Pressure (cmH2O)
LUS Guided Patient Position
The optimal PEEP right above the closing pressure
Time (minutes)
LUS Pattern
C-Pattern
S-Pattern
S-Pattern Increase
B-Pattern
RECRUİTED LUNG
The S-pattern; allows to distinguish the recruitable from the unrecruitable lung and guide the pressure titration phase.
Sunray lines" (S-lines) as they resemble sunrays crossing the clouds
Children 2022, 9, 1035.

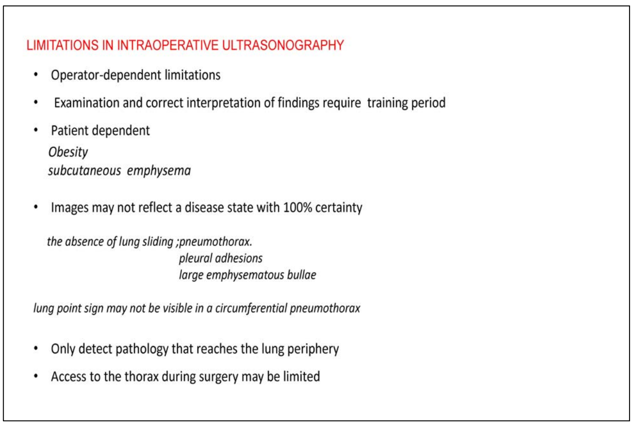

Ultrasonography for the assessment of lung recruitment maneuvers
Crit Ultrasound J (2016) 8:8
1. Check lung aeration
2. Asses hemodynamics
3. Start Recruitment
4. Find opening pressure
Detect ;Pplato/P driving
Oxygenation, complians
5. Detect the reaeration with USG
Opening pressure
Optimal PEEP
2 cmH2O above P closing
1 Check lung aeration
Evidence of lung collapse?
YES
NO
Keep protective ventilation
2 Check hemodynamics
Stable hemodynamics?
YES
NO
iv fluids
inotropes
vasoactive drugs
3 Find lung's opening and closing pressures
Paw (cmH2O)
REAERATION PATTERN; CONSOLIDATION → B LINES → A LINES
Closing pressure
4 Verify the effect of RM on lung aeration and hemodynamics


Effect of ultrasound-guided–pressure-controlled ventilation on intraoperative blood gas and ventilatory parameters during thoracic surgery
Indian J Anaesth 2020
1. Atelectasis was identified
2. P inspincreased by 2 cmH2O –15 s
3. Until atelectasis disappeared
4. Max limit;
Pplateau 25 cmH2O,
Ppeak 35 cmH2O
Ultrasound Guided –PCV ;
higher arterial oxygenation
better preservation of CO2
Physiological acid–base status
No complication
Real-time images of tidal recruitment using lung ultrasound
Crit Ultrasound J (2015)
probe within the intercostal space at the posterior axillary line just above the diaphragm
the oblique position between the ribs to identify atelectasis
probe in classical longitudinal approach during the tidal recruitment
1. step; perform recruitment maneveour
2. step; decrement in PEEP allowed the detection of the minimum level that prevents the reappearance of atelectasis in LUS images
Back to protective ventilation
End-expiration
End-inspiration
tidal recruitment
skin
sc
pleura
lung tissue
with lung recruitment


Intraoperative pulmonary hyperdistention estimated by transthoracic lung ultrasound: a pilot study
Anaesthesia Critical Care & Pain Medicine (2020)
18 patients with normal lungs undergoing lower abdominal surgery
RM+ Positive-end expiratory pressure (PEEP) descending trial – 20, 18, 16, 14, 12, 10, 8, 6, 4 cmH2O
Six or more A lines detected in normally aerated regions can be considered as indicating lung hyperdistention
PEEP 4 cmH2O
PEEP 20 cmH2O
Positive End-Expiratory Pressure (cmH2O)


Regional pleural strain measurements during mechanical ventilation using ultrasound elastography: A randomized, crossover, proof of concept physiologic study
10 patients / Vt: 6, 8, 10, and 12 mL.kg−1
screened 6 elastography parameters (lateral translation, lateral absolute translation, lateral strain, lateral absolute strain, lateral absolute shear
Muscle
Lung surface
preliminary evidence that computing regional pleural translation, strain and shear components is feasible in over 90% of cineloops.


SUMMARY-intraoperative period
1. Check lung aeration regularly
2. Find USG abnormal images;
(Consolidation, B lines)
3. Asses hemodynamics
4. Give proper position (if it is possible)
(most severely affected fields on the upper side)
5. Start Recruitment
Detect ;Pplato/P driving
Goal; optimum Oxygenation- complians
6. Detect the reaeration with USG
Normal A-line artifact
B-line pattern
Lung consolidation


LIMITATIONS IN INTRAOPERATIVE ULTRASONOGRAPHY
Operator-dependent limitations
Examination and correct interpretation of findings require training period
Patient dependent
Obesity
subcutaneous emphysema
Images may not reflect a disease state with 100% certainty
the absence of lung sliding ;pneumothorax.
pleural adhesions
large emphysematous bullae
lung point sign may not be visible in a circumferential pneumothorax
Only detect pathology that reaches the lung periphery
Access to the thorax during surgery may be limited

ASPA 2023

Session 2.

Experts' Advice of Monitoring for Better Anesthesia Care

Chair(s): Joy Luat-Inciong (Philippines)
Hyo-Jin Byon (Korea)

Blood Pressure Considerations in Pediatric Anesthesia: Challenges & Implications

Stephen J. Gleich

Mayo Clinic, USA

DISCLOSURES

- No Conflicts of Interest

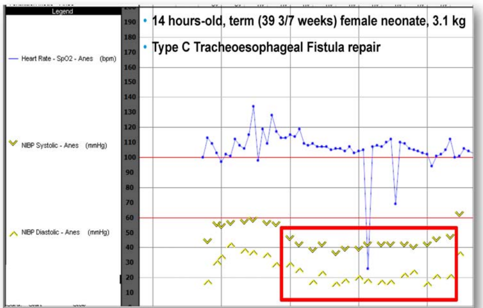
LEARNING OBJECTIVES

- Describe challenges in noninvasive automated blood pressure monitoring in anesthetized children.
- Identify complications of intraoperative hypotension.
- Discuss individualized blood pressure management strategies in anesthetized children.

PEDS INTRAOP BP

Case

- 14 hours-old, term (39 3/7 weeks) female neonate, 3.1 kg
- Type C Tracheoesophageal Fistula repair



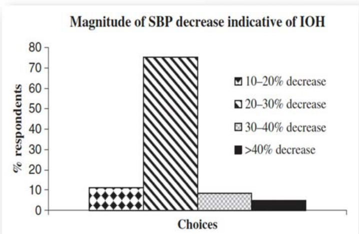
1 How is hypotension defined in children under anesthesia?

PEDS INTRAOP BP

Hypotension Definition

Pediatric Anesthesia

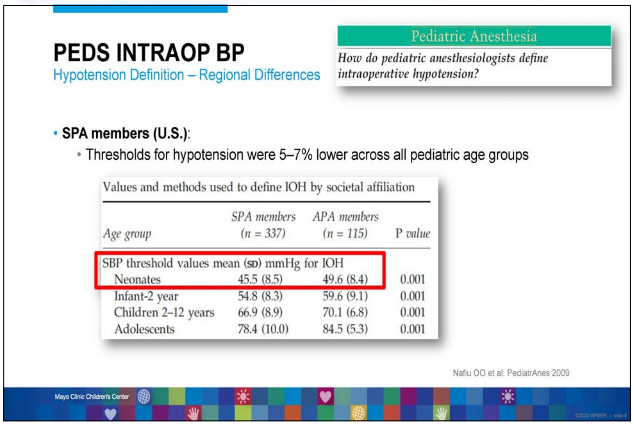
How do pediatric anesthesiologists define intraoperative hypotension?



Nafiu OO et al. PediatrAnes 2009

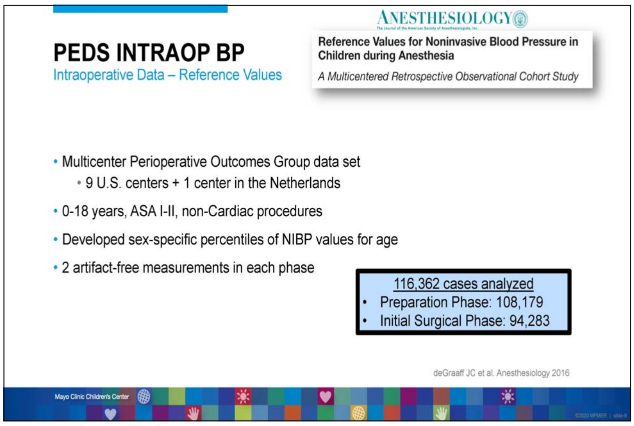
"Baseline" BP

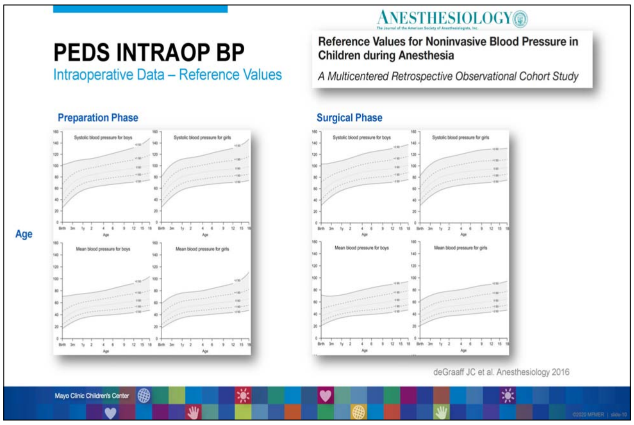
Sottas, CE et al. PediatrAnes 2016

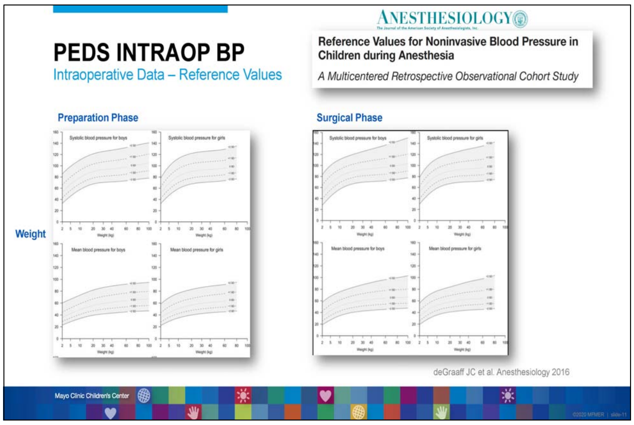


Values and methods used to define IOH by societal affiliation

Age group	SPA members (n = 337)	APA members (n = 115)	P value
SBP threshold values mean (SD) mmHg for IOH			
Neonates	45.5 (8.5)	49.6 (8.4)	0.001
Infant-2 year	54.8 (8.3)	59.6 (9.1)	0.001
Children 2–12 years	66.9 (8.9)	70.1 (6.8)	0.001
Adolescents	78.4 (10.0)	84.5 (5.3)	0.001







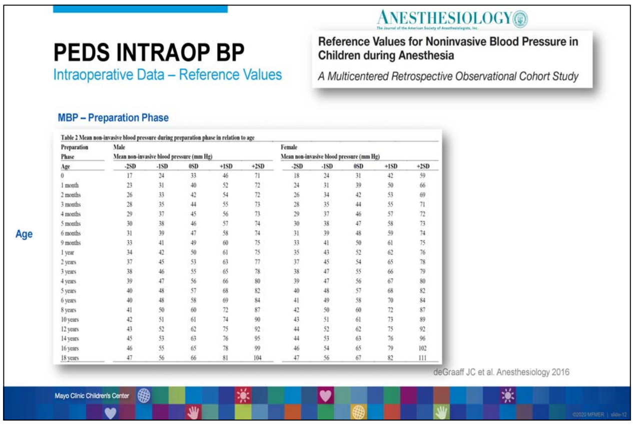
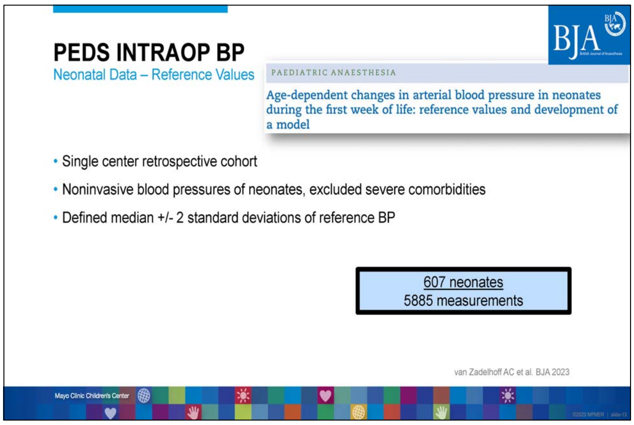
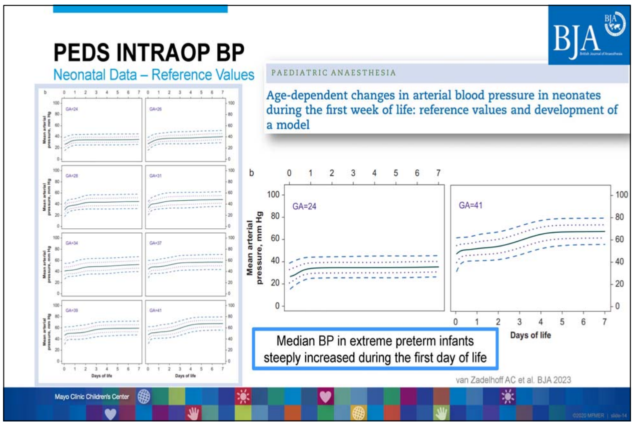
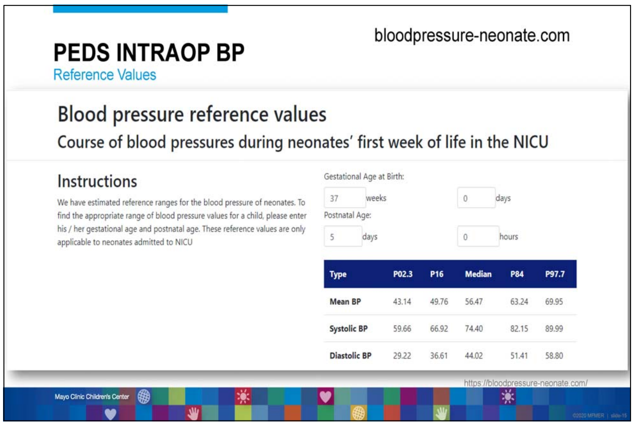


Table 2 Mean non-invasive blood pressure during preparation phase in relation to age

Preparation Phase	Male: Mean non-invasive blood pressure (mm Hg)					Female: Mean non-invasive blood pressure (mm Hg)				
Age	-2SD	-1SD	0SD	+1SD	+2SD	-2SD	-1SD	0SD	+1SD	+2SD
0	17	24	33	46	71	18	24	31	42	59
1 month	23	31	40	52	72	24	31	39	50	66
2 months	26	33	42	54	72	26	34	42	53	69
3 months	28	35	44	55	73	28	35	44	55	71
4 months	29	37	45	56	73	29	37	46	57	72
5 months	30	38	46	57	74	30	38	47	58	73
6 months	31	39	47	58	74	31	39	48	59	74
9 months	33	41	49	60	75	33	41	50	61	75
1 year	34	42	50	61	75	35	43	52	62	76
2 years	37	45	53	63	77	37	45	54	65	78
3 years	38	46	55	65	78	38	47	55	66	79
4 years	39	47	56	66	80	39	47	56	67	80
5 years	40	48	57	68	82	40	48	57	68	82
6 years	40	48	58	69	84	41	49	58	70	84
8 years	41	50	60	72	87	42	50	60	72	87
10 years	42	51	61	74	90	43	51	61	73	89
12 years	43	52	62	75	92	44	52	62	75	92
14 years	45	53	63	76	95	44	53	63	76	96
16 years	46	55	65	78	99	46	54	65	79	102
18 years	47	56	66	81	104	47	56	67	82	111







Type	P02.3	P16	Median	P84	P97.7
Mean BP	43.14	49.76	56.47	63.24	69.95
Systolic BP	59.66	66.92	74.40	82.15	89.99
Diastolic BP	29.22	36.61	44.02	51.41	58.80

PEDS INTRAOP BP
Intraoperative Data – Limitations

ANESTHESIOLOGY
Reference Values for Noninvasive Blood Pressure in Children during Anesthesia
A Multicentered Retrospective Observational Cohort Study

- No outcome data
- No "end-organ perfusion" data
- No correlation to:
  - Cerebral encephalopathy
  - Renal failure
  - Hospital LOS
  - Mortality
  - Long-term neurodevelopmental outcomes

deGraaff JC et al. Anesthesiology 2016

2 Challenges of intraoperative measurement of BP in children

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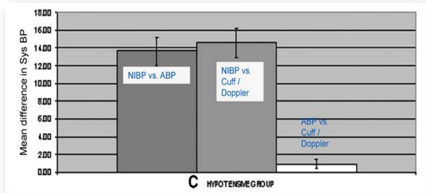
PEDS INTRAOP BP
BP Measurement – Method

Pediatric Critical Care Medicine
Which pressure to believe? A comparison of direct arterial with indirect blood pressure measurement techniques in the pediatric intensive care unit



Automated BP cuff readings were falsely elevated during hypotension

Holt TR et al. Pediatr Crit Care Med 2011

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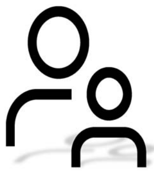
PEDS INTRAOP BP
BP Measurement – Anatomical Site



- Adults:
  - **Higher** BP measured in leg vs. arm

Moore C et al. Anaesthesia 2008

- Children (up to 8 years-old):
  - **LOWER** BP measured in leg vs. arm
  - Mean 10 mmHg lower 0-4 years

Short JA. Paediatr Anaesth 2000

Keidan I et al. JCA 2014

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3 Complications of hypotension

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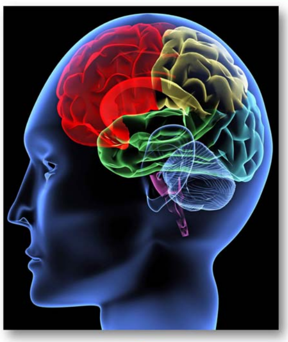

PEDS INTRAOP BP
Complications of Hypotension

CASE REPORT
Infantile Postoperative Encephalopathy: Perioperative Factors as a Cause for Concern

- 6 infants – undergoing elective procedures
- Developed postop encephalopathy
- Supratentorial watershed infarcts
- Outcomes:
  - 1 died, 2 had developmental delays, 2 normal
- **Presumed cause: cerebral hypoperfusion**

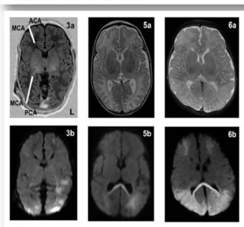

FIGURE 3

McCann ME et al. Pediatrics 2014

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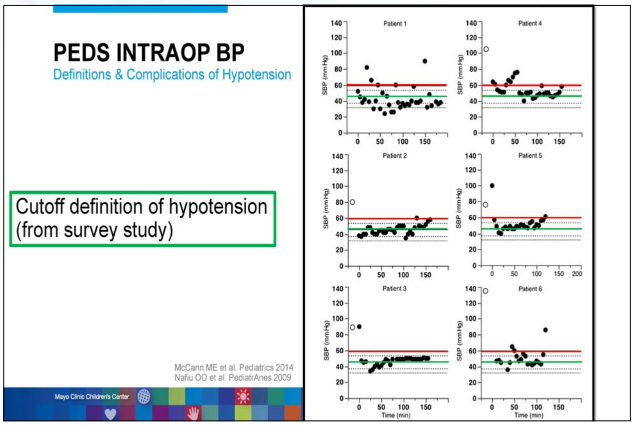
PEDS INTRAOP BP
Definitions & Complications of Hypotension
Cutoff definition of hypotension (from survey study)
McCann ME et al. Pediatrics 2014
Nafiu OO et al. PediatrAnes 2009
Patient 1
Patient 2
Patient 3
Patient 4
Patient 5
Patient 6
SBP (mmHg)
Time (min)
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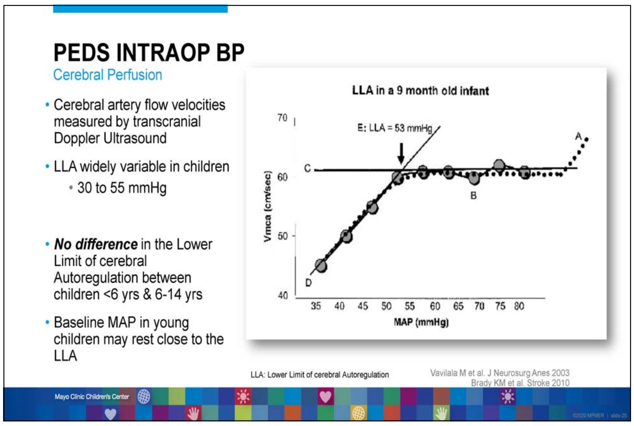
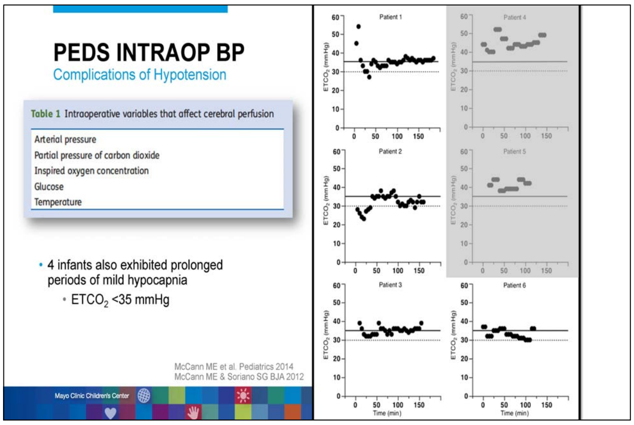
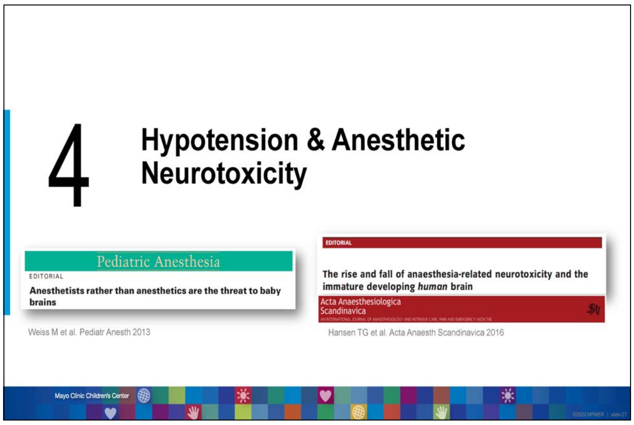
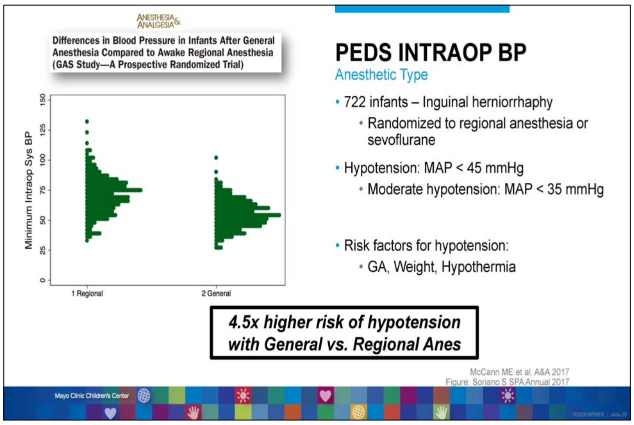
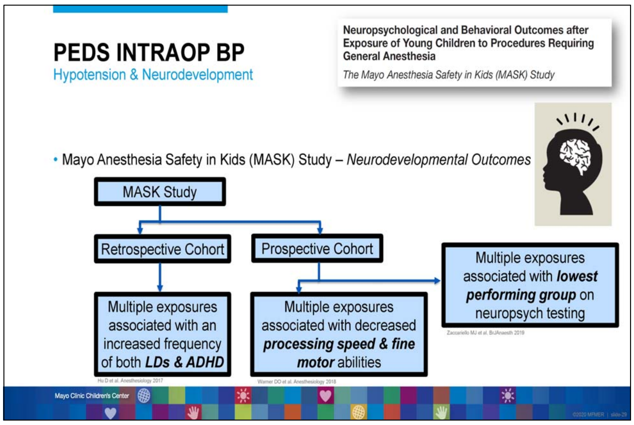
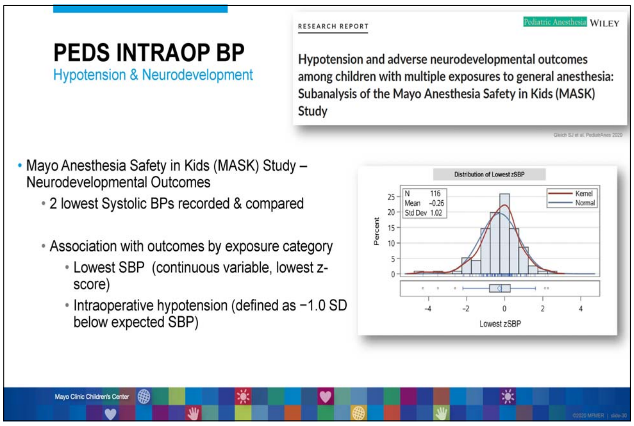

PEDS INTRAOP BP
Cerebral Perfusion
Cerebral artery flow velocities measured by transcranial Doppler Ultrasound
LLA widely variable in children
30 to 55 mmHg
No difference in the Lower Limit of cerebral Autoregulation between children <6 yrs & 6-14 yrs
Baseline MAP in young children may rest close to the LLA
LLA in a 9 month old infant
E: LLA = 53 mmHg
Vmca (cm/sec)
MAP (mmHg)
LLA: Lower Limit of cerebral Autoregulation
Vavilala M et al. J Neurosurg Anes 2003
Brady KM et al. Stroke 2010
Mayo Clinic Children's Center

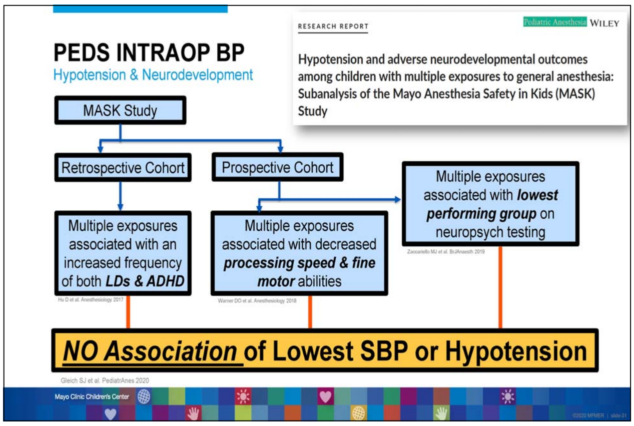

PEDS INTRAOP BP
Complications of Hypotension
Table 1 Intraoperative variables that affect cerebral perfusion
Arterial pressure
Partial pressure of carbon dioxide
Inspired oxygen concentration
Glucose
Temperature
4 infants also exhibited prolonged periods of mild hypocapnia
ETCO2 <35 mmHg
McCann ME et al. Pediatrics 2014
McCann ME & Soriano SG BJA 2012
Patient 1
Patient 2
Patient 3
Patient 4
Patient 5
Patient 6
Time (min)
Mayo Clinic Children's Center


4
Hypotension & Anesthetic Neurotoxicity
Pediatric Anesthesia
EDITORIAL
Anesthetists rather than anesthetics are the threat to baby brains
Weiss M et al. Pediatr Anesth 2013
EDITORIAL
The rise and fall of anaesthesia-related neurotoxicity and the immature developing human brain
Acta Anaesthesiologica Scandinavica
Hansen TG et al. Acta Anaesth Scandinavica 2016
Mayo Clinic Children's Center


Differences in Blood Pressure in Infants After General Anesthesia Compared to Awake Regional Anesthesia (GAS Study—A Prospective Randomized Trial)
Minimum Intraop Sys BP
1 Regional
2 General
PEDS INTRAOP BP
Anesthetic Type
722 infants – Inguinal herniorrhaphy
Randomized to regional anesthesia or sevoflurane
Hypotension: MAP < 45 mmHg
Moderate hypotension: MAP < 35 mmHg
Risk factors for hypotension:
GA, Weight, Hypothermia
4.5x higher risk of hypotension with General vs. Regional Anes
McCann ME et al. A&A 2017
Figure: Soriano S SPA Annual 2017
Mayo Clinic Children's Center


PEDS INTRAOP BP
Hypotension & Neurodevelopment
Neuropsychological and Behavioral Outcomes after Exposure of Young Children to Procedures Requiring General Anesthesia
The Mayo Anesthesia Safety in Kids (MASK) Study
Mayo Anesthesia Safety in Kids (MASK) Study – Neurodevelopmental Outcomes
MASK Study
Retrospective Cohort
Prospective Cohort
Multiple exposures associated with an increased frequency of both LDs & ADHD
Multiple exposures associated with decreased processing speed & fine motor abilities
Multiple exposures associated with lowest performing group on neuropsych testing
Mayo Clinic Children's Center


PEDS INTRAOP BP
Hypotension & Neurodevelopment
RESEARCH REPORT
Hypotension and adverse neurodevelopmental outcomes among children with multiple exposures to general anesthesia: Subanalysis of the Mayo Anesthesia Safety in Kids (MASK) Study
Mayo Anesthesia Safety in Kids (MASK) Study – Neurodevelopmental Outcomes
2 lowest Systolic BPs recorded & compared
Association with outcomes by exposure category
Lowest SBP (continuous variable, lowest z-score)
Intraoperative hypotension (defined as −1.0 SD below expected SBP)
Distribution of Lowest zSBP
Percent
Lowest zSBP
Mayo Clinic Children's Center


PEDS INTRAOP BP
Hypotension & Neurodevelopment
RESEARCH REPORT
Hypotension and adverse neurodevelopmental outcomes among children with multiple exposures to general anesthesia: Subanalysis of the Mayo Anesthesia Safety in Kids (MASK) Study
MASK Study
Retrospective Cohort
Prospective Cohort
Multiple exposures associated with an increased frequency of both LDs & ADHD
Multiple exposures associated with decreased processing speed & fine motor abilities
Multiple exposures associated with lowest performing group on neuropsych testing
NO Association of Lowest SBP or Hypotension
Gleich SJ et al. PediatrAnes 2020
Mayo Clinic Children's Center

FUTURE

ANESTHESIOLOGY

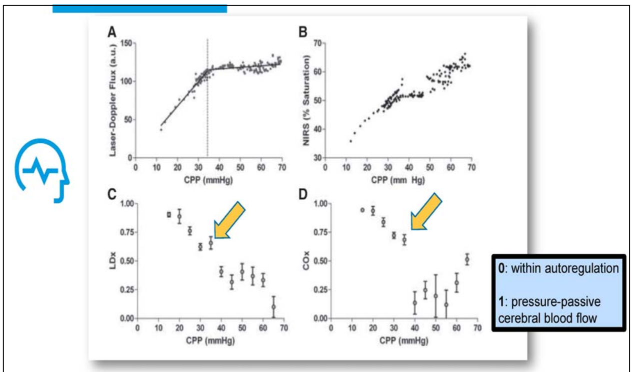
Personalizing the Definition of Hypotension to Protect the Brain

Kenneth M. Brady, M.D., Aaron Hudson, M.D., Ryan Hood, M.D., Bruno DeCaria, M.D., Choy Lewis, M.D., Charles W. Hogue, M.D.

- Accurate and affordable non-invasive monitors to detect decrease in cerebral blood flow
  - Correlation to standard BP measurements
- Prompt treatments to maintain adequate blood pressure and cerebral perfusion

Brady K et al. Anesthesiology 2020

Mayo Clinic Children's Center



Brady K et al. Anesthesiology 2020

Mayo Clinic Children's Center

PEDS INTRAOP BP

Conclusions

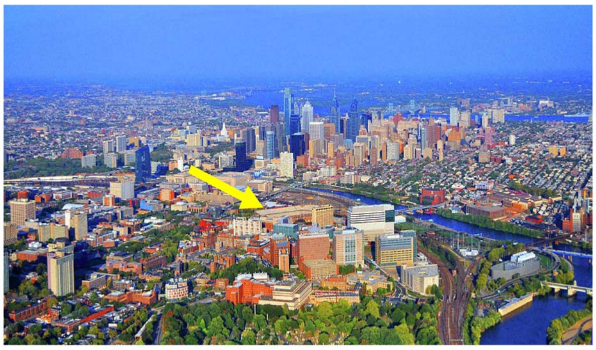
- BP measurement & evaluation in children under anesthesia – should be individualized
- Hampered by inaccurate measurements of automated NIBP
- Reference ranges – not linked to clinical outcomes
- BP is 1 component of multifactorial cerebral perfusion
  - Inadequate cerebral perfusion → devastating neurologic consequences
- **Future: outcome-based studies & monitors**

Neuromonitoring in Neonatal Pain Assessment

Ian Yuan

Children's Hospital of Philadelphia, USA

Oldest Children's Hospital in USA



Childrens Hospital of Philadelphia (CHOP)

33,000 cases / year

75 Pediatric Anesthesiologist (9 Cardiac)

30 Nurse Anesthetists

11 Fellows

10 Residents

???

1- Hungry

2- Tired

3- In pain from surgery

Neuromonitoring in Neonatal Pain Assessment

Consequences of untreated neonatal pain

Neuromonitoring to assess neonatal pain

Near-infrared spectroscopy pain assessment

Misconceptions in Neonatal Pain

- Immature pain pathways and cannot transmit painful stimulus to brain.
- Lack context to identify experiences as painful.
- Analgesic or sedative agents cause adverse effects to the developing brain

Neonatal Pain -> Worse Postop Outcomes

THE LANCET

Volume 329, Issue 8527, 31 January 1987, Pages 243-248

RANDOMISED TRIAL OF FENTANYL ANAESTHESIA IN PRETERM BABIES UNDERGOING SURGERY: EFFECTS ON THE STRESS RESPONSE

K.J.S. Anand, W.G. Sippell, A.Aynsley Green

PDA ligation in babies
without *vs* without fentanyl

↑ **stress response** (adrenaline, noradrenaline, glucagon, corticosterone, lactate)

↑ **protein catabolism** at POD#3

Worse outcomes: ↑ventilation requirement, bradycardia, hypotension, metabolic acidosis, intraventricular hemorrhage.

Neonatal Pain -> Increased Pain Sensitivity

THE LANCET

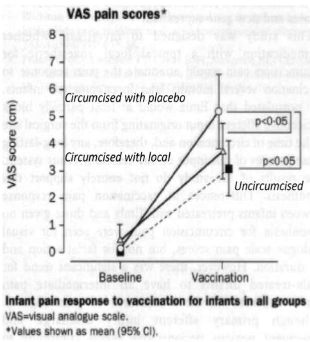
Volume 349, Issue 9052, 1 March 1997, Pages 599-603

Articles

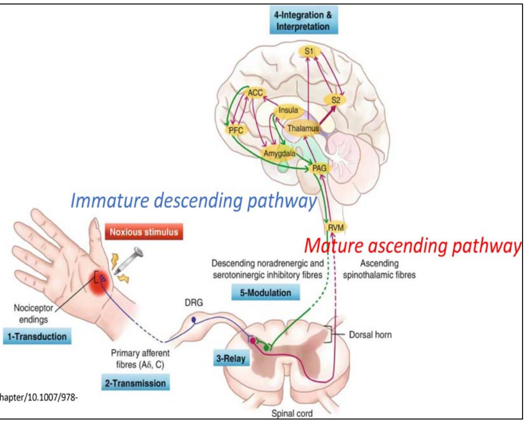
Effect of neonatal circumcision on pain response during subsequent routine vaccination

Anna Taddio MSc, Joel Katz PhD, A Lane Ilersich MSc, Prof Gideon Koren

Pain response at 4 or 6mo vaccinations in babies circumcised with local *vs* with placebo *vs* uncircumcised.



Infant pain response to vaccination for infants in all groups
VAS=visual analogue scale.
*Values shown as mean (95% CI).



https://link.springer.com/chapter/10.1007/978-3-030-87266-3_36

Neuromonitoring in Neonatal Pain Assessment

Consequences of untreated neonatal pain

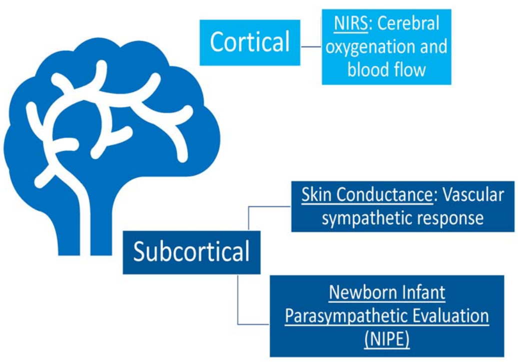
Neuromonitoring to assess neonatal pain

Neuromonitoring Neonatal Nociception

- Skin conductance test
- Newborn Infant Parasympathetic Evaluation (NIPE)
- Near infrared spectroscopy

- Surgical Pleth Index
- ANI (Analgesia nociception index)
- Pupillometer

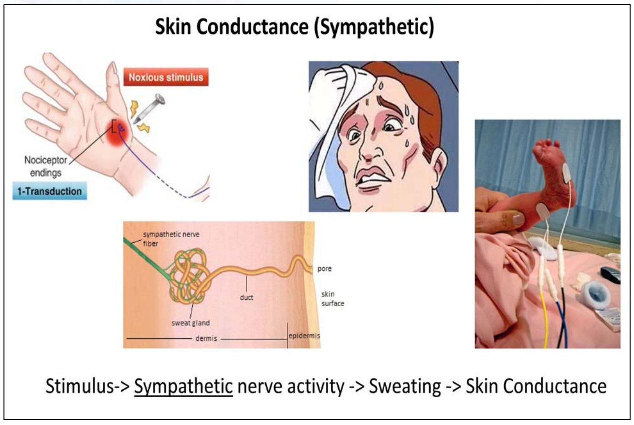
Sabourdin N, Current Opinion in Anaesthesiology. 2022

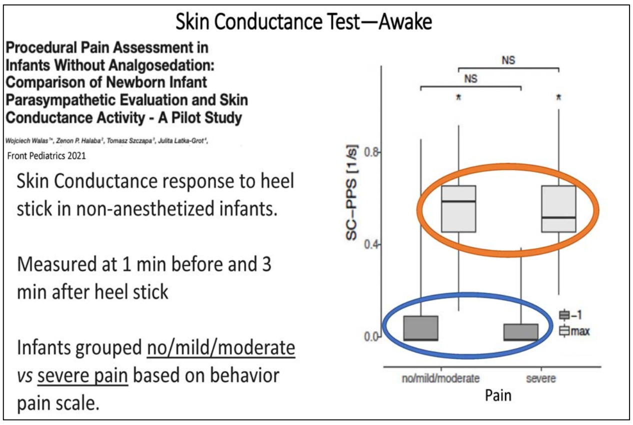


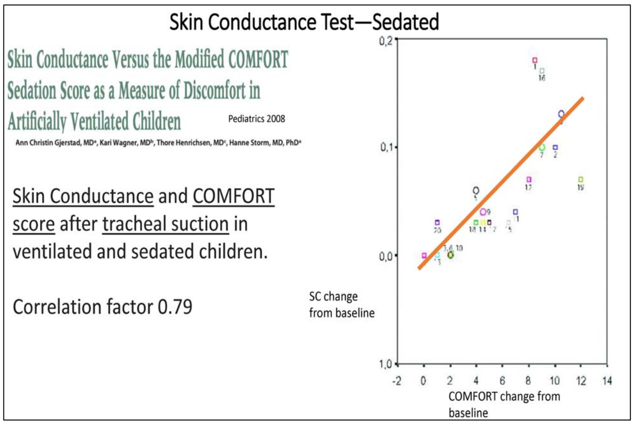
Summary of neonatal pain assessment tools

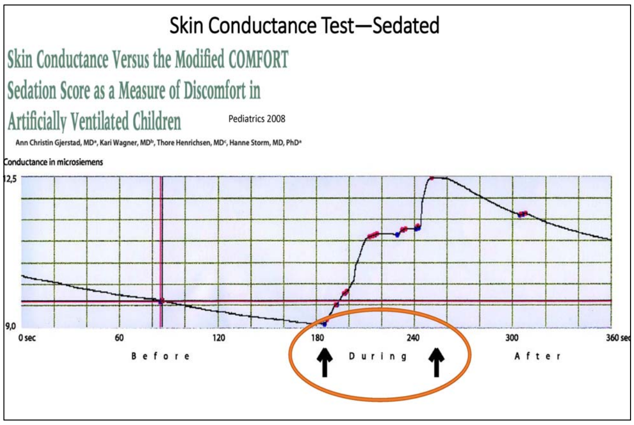
Pain Assessment Tool	Gestational Age	Physiologic Components	Behavioral Components	Type of Pain	Adjusts for Prematurity	Scale Metric
Premature Infant Pain Profile-Revised (PIPP-R)[67,68]	26 wk to term	Heart rate, oxygen saturation	Alertness, brow bulge, ey[e] squeeze, nasolabial [fu]rrow	Procedural and postoperative	Yes	0–21
Cries, Requires Oxygen, Increased Vital Signs, Expression, Sleeplessness (CRIES)[69]	32–56 wk	Blood pressure, heart rate, oxygen saturation	Cry, expression, sleeplessness	Postoperative	No	0–10
Neonatal Infant Pain Scale (NIPS)[70]	28–38 wk	Breathing pattern	Facial expression, cry, arms, legs, alertness	Procedural	No	0–7
COMFORT (and COMFORTneo)[37,71]	0–3 y (COMFORTneo: 24–42 wk)	Respiratory response, blood pressure, heart rate	Alertness, agitation, physical movements, muscle tone, facial tension	Postoperative (COMFORTneo: prolonged)	No	8–40
Neonatal Facial Coding System (NFCS)[72]	25 wk to term	None	Brow bulge, eye squeeze, nasolabial furrow, open lips, stretch mouth (vertical and horizontal), lip purse, taut tongue, chin quiver	Procedural	No	0–10
Neonatal Pain, Agitation, and Sedation Scale (N-PASS)[35]	0–100 d	Heart rate, respiratory rate, blood pressure, oxygen saturation	Crying or irritability, behavior state, facial expression, extremities or tone	Acute and prolonged pain Also assesses sedation	Yes	Pain: 0–10 Sedation −10–0
Échelle de la Douleur Inconfort Noveau-Né (EDIN; Neonatal Pain and Discomfort) Scale[34]	25–36 wk	None	Facial activity, body movements, quality of sleep, quality of contact with nurses, consolability	Prolonged	No	0–15
Bernese Pain Scale for Neonates (BPSN)[73]	27–41 wk	Respiratory pattern, heart rate, oxygen saturation	Alertness, duration of cry, time to calm, skin color, brow bulge with eye squeeze, posture	Procedural	No	0–27

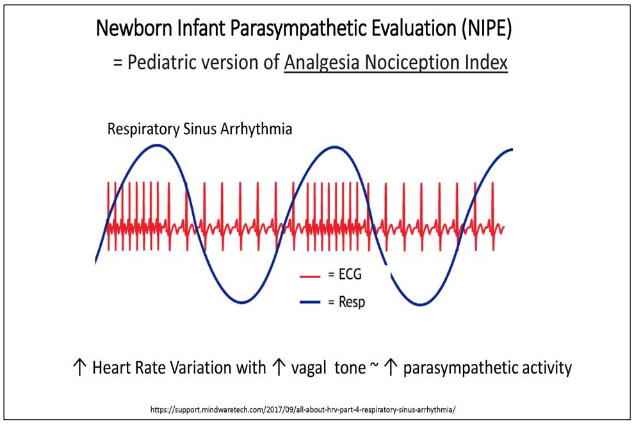
Maxwell LG et al. Assessment of pain in the newborn: an update. Clinics in perinatology. 2019

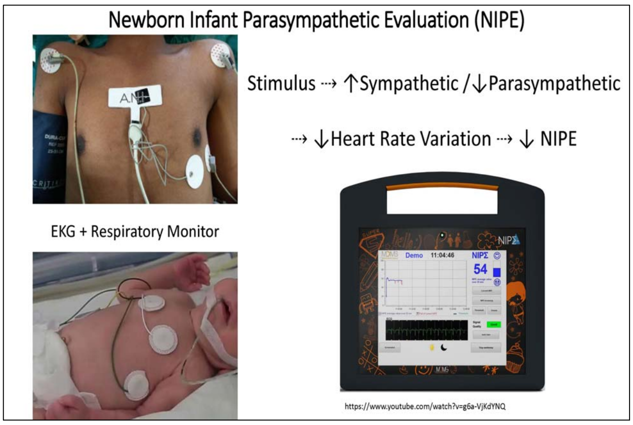

Skin Conductance (Sympathetic)
Noxious stimulus
Nociceptor endings
1-Transduction
sympathetic nerve fiber
pore
skin surface
duct
sweat gland
dermis
epidermis
Stimulus-> Sympathetic nerve activity -> Sweating -> Skin Conductance

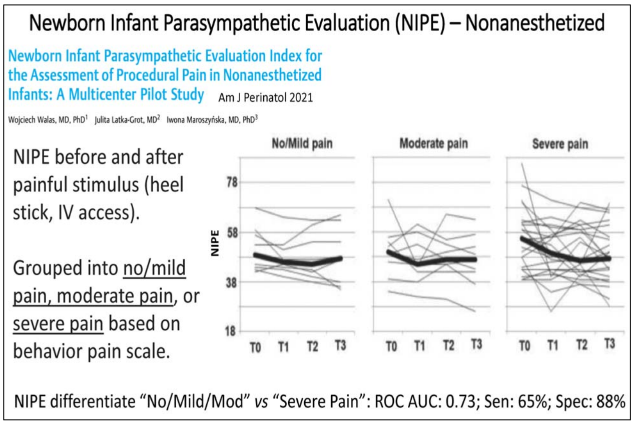

Skin Conductance Test—Awake
Procedural Pain Assessment in Infants Without Analgosedation: Comparison of Newborn Infant Parasympathetic Evaluation and Skin Conductance Activity - A Pilot Study
Front Pediatrics 2021
Skin Conductance response to heel stick in non-anesthetized infants.
Measured at 1 min before and 3 min after heel stick
Infants grouped no/mild/moderate vs severe pain based on behavior pain scale.
SC–PPS [1/s]
NS
NS
no/mild/moderate
severe
Pain

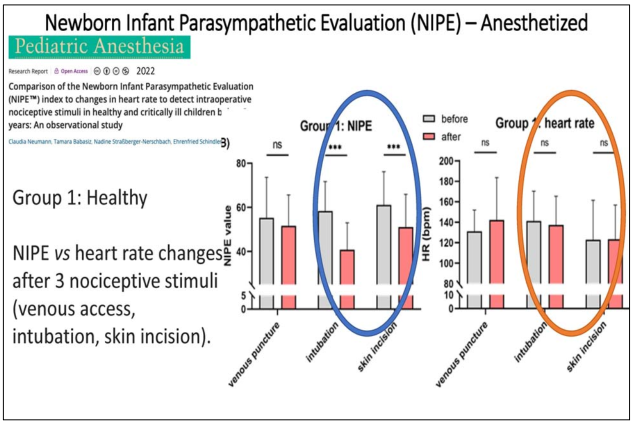

Skin Conductance Test—Sedated
Skin Conductance Versus the Modified COMFORT Sedation Score as a Measure of Discomfort in Artificially Ventilated Children
Pediatrics 2008
Skin Conductance and COMFORT score after tracheal suction in ventilated and sedated children.
Correlation factor 0.79
SC change from baseline
COMFORT change from baseline


Skin Conductance Test—Sedated
Skin Conductance Versus the Modified COMFORT Sedation Score as a Measure of Discomfort in Artificially Ventilated Children
Pediatrics 2008
Conductance in microsiemens
Before
During
After


Newborn Infant Parasympathetic Evaluation (NIPE)
= Pediatric version of Analgesia Nociception Index
Respiratory Sinus Arrhythmia
= ECG
= Resp
↑ Heart Rate Variation with ↑ vagal tone ~ ↑ parasympathetic activity
https://support.mindwaretech.com/2017/09/all-about-hrv-part-4-respiratory-sinus-arrhythmia/


Newborn Infant Parasympathetic Evaluation (NIPE)
Stimulus ⇢ ↑Sympathetic / ↓Parasympathetic
⇢ ↓Heart Rate Variation ⇢ ↓ NIPE
EKG + Respiratory Monitor
https://www.youtube.com/watch?v=g6a-VjKdYNQ


Newborn Infant Parasympathetic Evaluation (NIPE) – Nonanesthetized
Newborn Infant Parasympathetic Evaluation Index for the Assessment of Procedural Pain in Nonanesthetized Infants: A Multicenter Pilot Study
Am J Perinatol 2021
NIPE before and after painful stimulus (heel stick, IV access).
Grouped into no/mild pain, moderate pain, or severe pain based on behavior pain scale.
No/Mild pain
Moderate pain
Severe pain
NIPE differentiate “No/Mild/Mod” vs “Severe Pain”: ROC AUC: 0.73; Sen: 65%; Spec: 88%


Newborn Infant Parasympathetic Evaluation (NIPE) – Anesthetized
Pediatric Anesthesia
Comparison of the Newborn Infant Parasympathetic Evaluation (NIPE™) index to changes in heart rate to detect intraoperative nociceptive stimuli in healthy and critically ill children below 2 years: An observational study
Group 1: Healthy
NIPE vs heart rate changes after 3 nociceptive stimuli (venous access, intubation, skin incision).
Group 1: NIPE
Group 1: heart rate
before
after
venous puncture
intubation
skin incision

Newborn Infant Parasympathetic Evaluation (NIPE) – Anesthetized

Pediatric Anesthesia

Research Report · Open Access · 2022

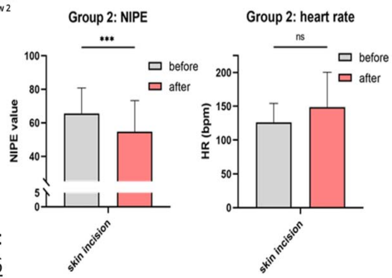
Comparison of the Newborn Infant Parasympathetic Evaluation (NIPE™) index to changes in heart rate to detect intraoperative nociceptive stimuli in healthy and critically ill children below 2 years: An observational study

Claudia Neumann, Tamara Babasic, Nadine Straßberger-Nerschbach, Ehrenfried Schindler.

Group 2: Critically ill, intubated from ICU.

NIPE *vs* heart rate changes during skin incision.

ROC-AUC to detect stimulus: NIPE *vs* Heart Rate 0.9 *vs* 0.6



Neuromonitoring in Neonatal Pain Assessment

Consequences of untreated neonatal pain

Neuromonitoring to assess neonatal pain

Near-infrared spectroscopy pain assessment

Cortical

NIRS: Cerebral oxygenation and blood flow

Skin Conductance: Vascular sympathetic response

Subcortical

Newborn Infant Parasympathetic Evaluation (NIPE)

NIRS *vs* PulseOx

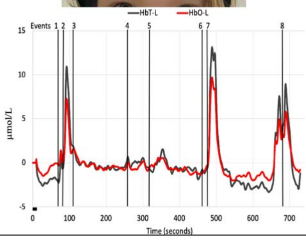
Similar

- Measure light absorption ratio of HbO/Hb.
- Subject to motion and light artifact.
- Depends on manufacturer algorithm.

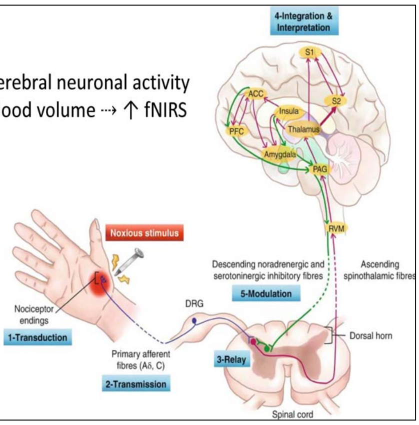
Different

- PulseOx:
  Arterial saturation and O_2 supply.
- NIRS:
  Venous saturation (~75%), O_2 supply and demand.
  Not dependent on pulsatile flow.

NIRS *vs* functional NIRS (fNIRS)



Stimulus ⇢ ↑ cerebral neuronal activity ⇢ ↑ cerebral blood volume ⇢ ↑ fNIRS



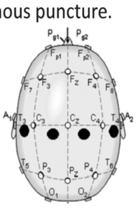
https://link.springer.com/chapter/10.1007/978-3-030-87266-3_36

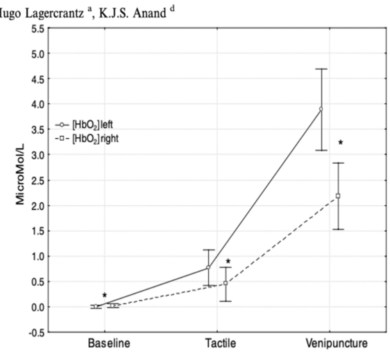
Pain (2006)

Pain activates cortical areas in the preterm newborn brain

Marco Bartocci [a,b,*], Lena L. Bergqvist [a,c], Hugo Lagercrantz [a], K.J.S. Anand [d]

Preterm neonates during venous puncture.





↑ fNIRS ~ ↑ postnatal age

↑ fNIRS ~ ↓ gestational

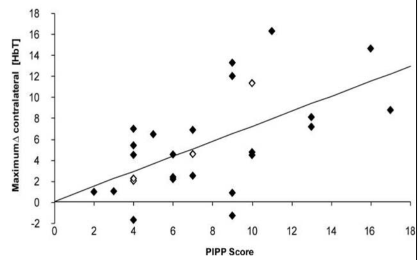
How Well Do Clinical Pain Assessment Tools Reflect Pain in Infants?

PLoS Med. 2008

Rebeccah Slater,[1,*] Anne Cantarella,[2] Linda Franck,[3] Judith Meek,[2] and Maria Fitzgerald[1]

fNIRS *vs* premature infant pain profile (PIPP) after heel lance

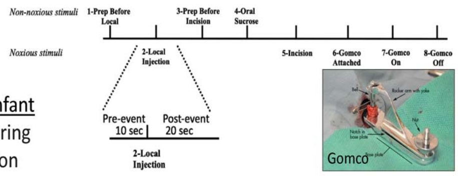
fNIRS correlation with PIPP Behavioral (0.74) *vs* PIPP Physiological (0.4)



Functional near-infrared spectroscopy to assess pain in neonatal circumcisions

Pediatric Anesthesia. 2022

Ian Yuan[1] | Olivia Nelson[1] | Gordon A. Barr[1] | Bingqing Zhang[2] |



fNIRS *vs* Neonatal Infant Pain Scale (NIPS) during newborn circumcision

fNIRS on frontal cortex

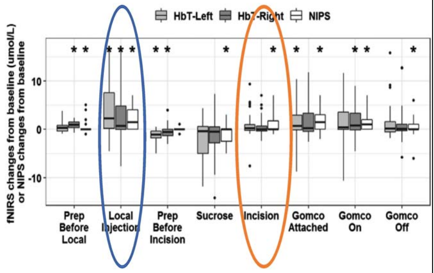
Functional near-infrared spectroscopy to assess pain in neonatal circumcisions

Pediatric Anesthesia. 2022

Ian Yuan[1] | Olivia Nelson[1] | Gordon A. Barr[1] | Bingqing Zhang[2] |

During incision, local anesthetic blunted fNIRS response but not NIPS

Weak correlation between fNIRS *vs* NIPS



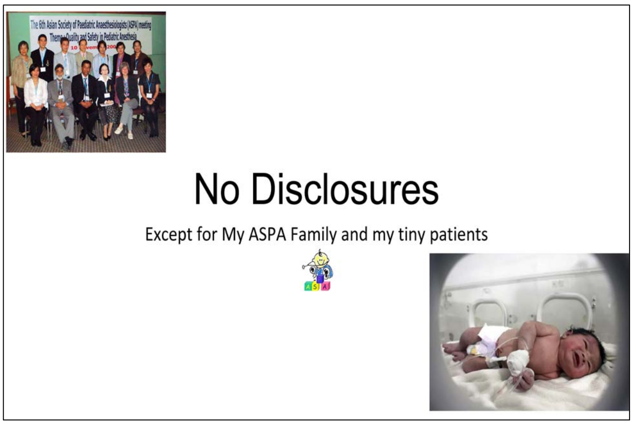
Summary

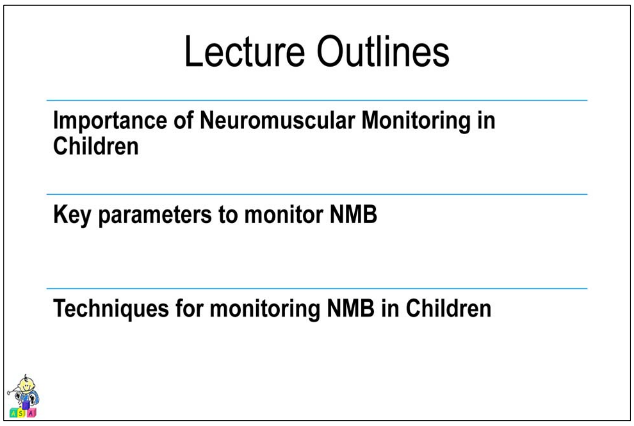
- No "gold standard" for pain assessment
- Many devices still in research stage.
- Much research still needed in neonates… (especially under anesthesia)

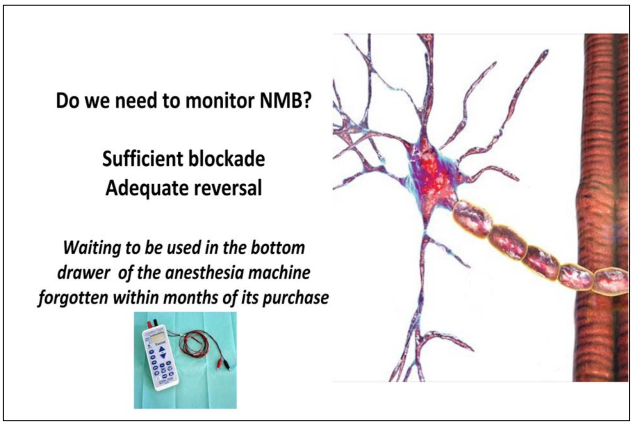
Accurate and Reliable Neuromuscular Monitoring in Children

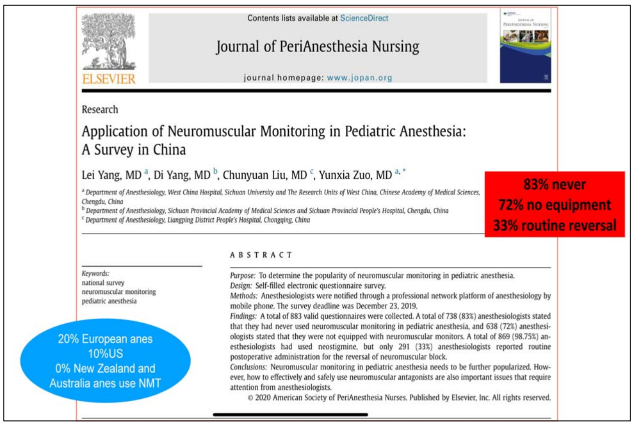
Z Serpil Ustalar Ozgen

University of Mehmet Ali Aydinlar University, Türkiye









Contents lists available at ScienceDirect

Journal of PeriAnesthesia Nursing

journal homepage: www.jopan.org

Research

Application of Neuromuscular Monitoring in Pediatric Anesthesia: A Survey in China

Lei Yang, MD [a], Di Yang, MD [b], Chunyuan Liu, MD [c], Yunxia Zuo, MD [a,*]

[a] Department of Anesthesiology, West China Hospital, Sichuan University and The Research Units of West China, Chinese Academy of Medical Sciences, Chengdu, China
[b] Department of Anesthesiology, Sichuan Provincial Academy of Medical Sciences and Sichuan Provincial People's Hospital, Chengdu, China
[c] Department of Anesthesiology, Liangping District People's Hospital, Chongqing, China

Keywords:
national survey
neuromuscular monitoring
pediatric anesthesia

ABSTRACT

Purpose: To determine the popularity of neuromuscular monitoring in pediatric anesthesia.
Design: Self-filled electronic questionnaire survey.
Methods: Anesthesiologists were notified through a professional network platform of anesthesiology by mobile phone. The survey deadline was December 23, 2019.
Findings: A total of 883 valid questionnaires were collected. A total of 738 (83%) anesthesiologists stated that they had never used neuromuscular monitoring in pediatric anesthesia, and 638 (72%) anesthesiologists stated that they were not equipped with neuromuscular monitors. A total of 869 (98.75%) anesthesiologists had used neostigmine, but only 291 (33%) anesthesiologists reported routine postoperative administration for the reversal of neuromuscular block.
Conclusions: Neuromuscular monitoring in pediatric anesthesia needs to be further popularized. However, how to effectively and safely use neuromuscular antagonists are also important issues that require attention from anesthesiologists.
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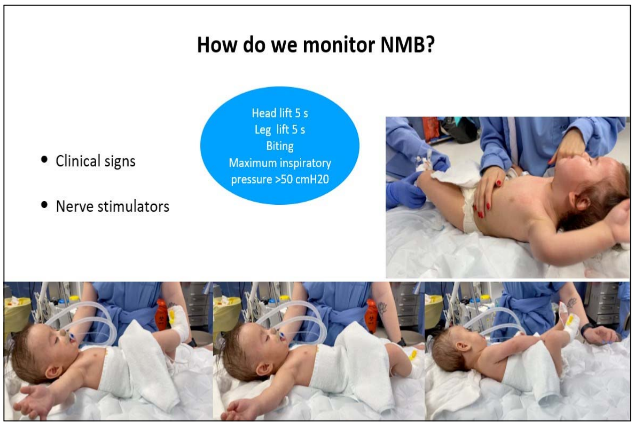
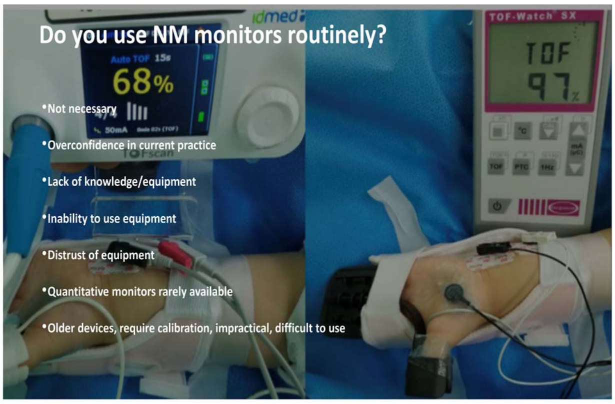
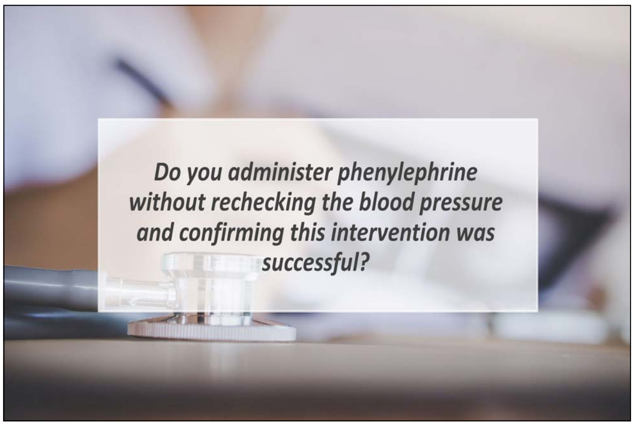






WHY?

Clinical assessment is challenging in children

- **Difficulties in communication**
- **Non-compliance to instructions**

10-28% of children experience postoperative residual block

Complications due to residual block can be detrimental

- **smaller oxygen reserves**
- **more vulnerable to airway collapse**

Limitations of NM Monitoring in Neonates

- Variability in response- gestational age, postnatal age, weight, coexisting medical conditions
- Lack of standardized guidelines
- Technical difficulties
- Influence of temperature
- Influence of coexisting conditions – prematurity, congenital anomalies, NM diseases
- Limited pharmacokinetic data- organ immaturity, altered protein binding, different rates of drug metabolism and elimination
- Relevance of monitoring data- ongoing research and debate

Why do we want to monitor NMB?

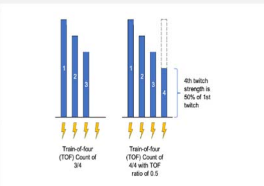
Stimulation pattern	Onset of block	Deep block (TOF=0)	Moderate block (TOF>0)	Recovery
Train-of-four(TOF)	Adequate	Not adequate	Adequate	Intermediate(a) Adequate(b)
Double burst stimulation(DBS)	Intermediate	Not adequate	Not adequate	Intermediate
Post-tetanic count(PTC)	Not adequate	Adequate	Not adequate	Not adequate
Tetanus (50/100Hz)	Not adequate	Not adequate	Not adequate	Intermediate

Single twitch

- Supramaximal stimulus frequency 0.1-1.0 Hz
- Limited value in clinical setting
- Useful for baseline assessment of NM function before the administration of NMBAs

Train-of-four (TOF)

- **Stimulation pattern 4 twitches at 2 Hz**
- **Loss of fourth response 75-80% NMB**
- **Sufficient NMB for surgical procedure: until reappearance of 2-4 responses**
- **TOF Ratio 0.7 = adequate diaphragmatic recovery**
- **TOF Ratio >0.9 = adequate Pharyngeal muscle function**



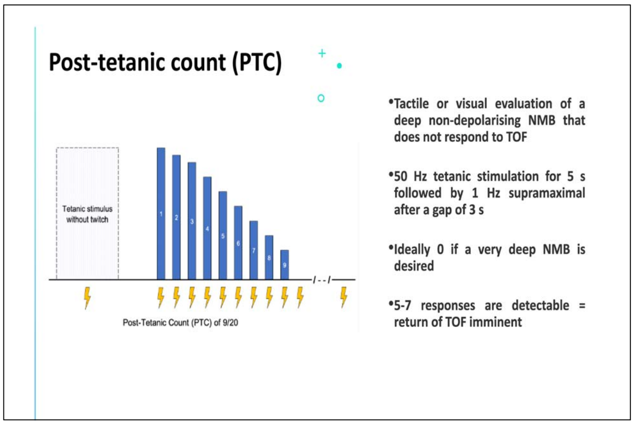
Provides information about the depth of NMB and the degree of recovery after reversal

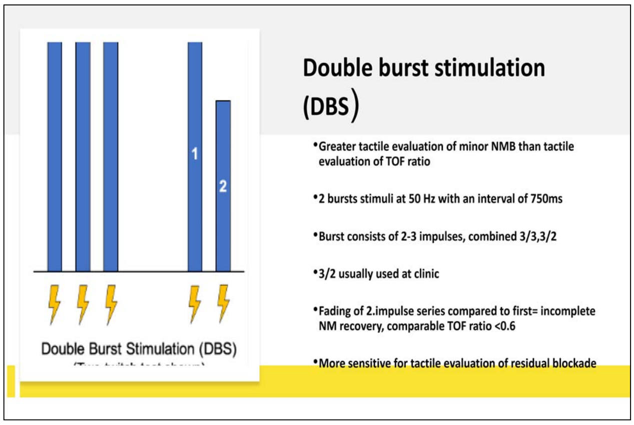
TOF ratio below 0.9 suggests the presence of residual blockade

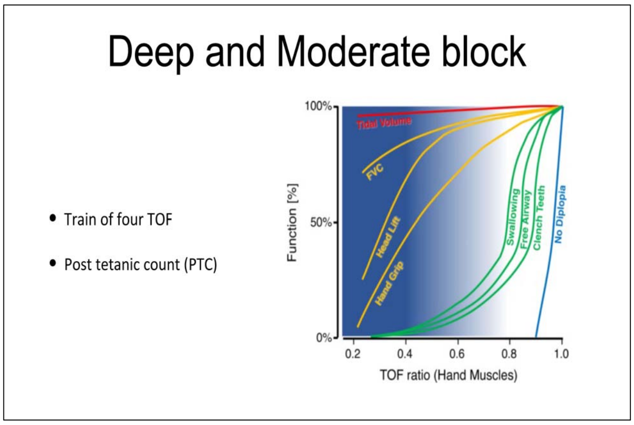
Disappearance of responses	3	2	1
NMB	85%	90%	100%

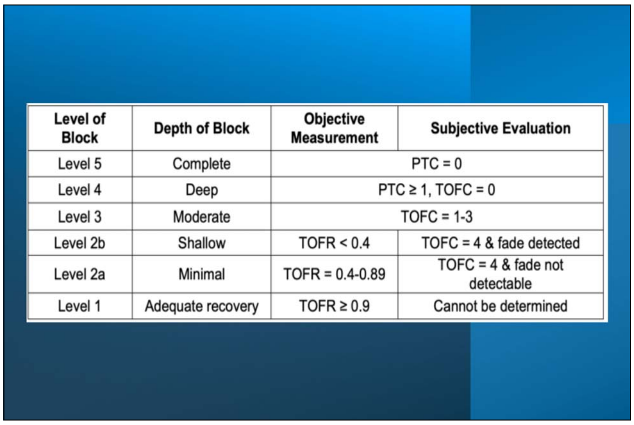
Tetanic Stimulation

- High frequency (50-200) Hz stimulation applied for 5 s
- Fade effect in incomplete NMB recovery
- Sensitivity of using TS in detecting residual curarisation 70%, specifity 50%

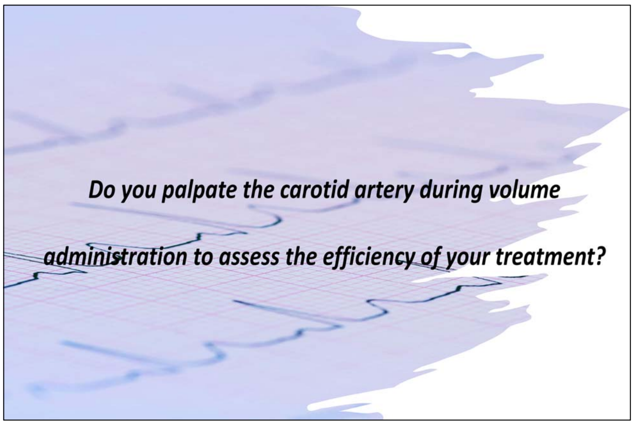


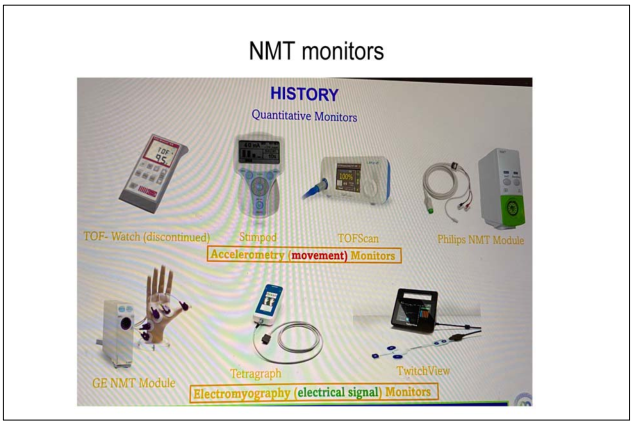


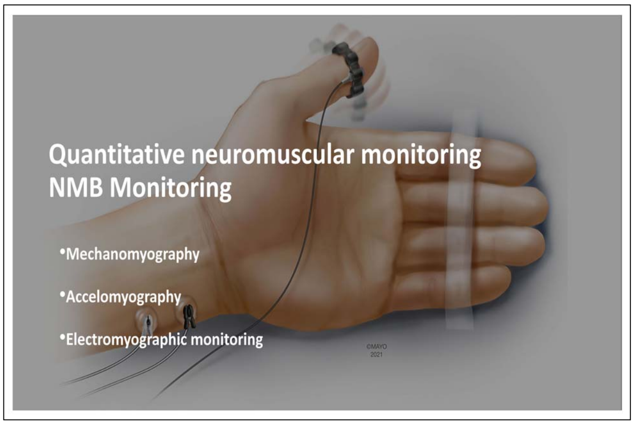


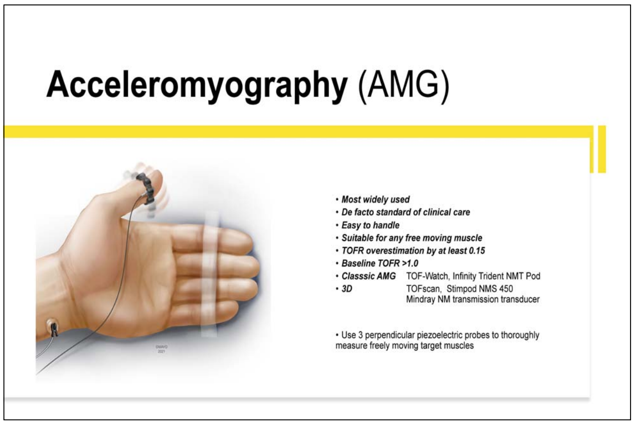


Level of Block	Depth of Block	Objective Measurement	Subjective Evaluation
Level 5	Complete	PTC = 0	
Level 4	Deep	PTC ≥ 1, TOFC = 0	
Level 3	Moderate	TOFC = 1-3	
Level 2b	Shallow	TOFR < 0.4	TOFC = 4 & fade detected
Level 2a	Minimal	TOFR = 0.4-0.89	TOFC = 4 & fade not detectable
Level 1	Adequate recovery	TOFR ≥ 0.9	Cannot be determined









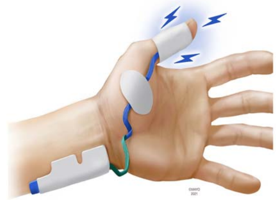
Kinemyography

- Easy to use
- Available only for the ulnar nerve-APM group
- Free thumb movement required
- Good strip placement between the fingers required

- Datex Ohmeda
- NMT
- MechanoSensor

- Measurement of the electrical signal generated by the bending of a piezoelectric sensor strip placed between the thumb and the index

Electromyography



- Best indicator of pure NM function
- Free muscle movement not required
- Influenced by other electronic devices in OR (diathermy) or local temperature

- Measurement of the muscle action potential following nerve stimulation

Cuff-based Monitoring Compressomyography (CMG)

- No need for free arm movement
- TOFR >0.9 correlates well with a MMG TOFR>0.7

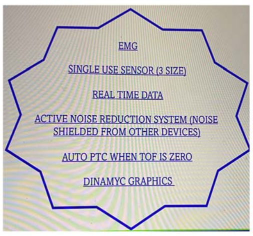
- TOF-Cuff

- No need for free arm movement Modified non-invasive BP cuff measuring the block depth by brachial plexus stimulation through electrodes attached on its inner surface

Monitor	Advantages	Disadvantages
MMG	Considered the "gold standard", as results are precise and reliable.	Inconvenient set-up process. Not manufactured for clinical use. (Research uses only.)
KMG	Simple setup that does not require an external display or calibration.	Can only be deployed at the APM.
AMG	Can be deployed on any free-moving muscle, including locations on the hand, foot, or face.	Cannot be deployed on immobilized muscles. Greatest accuracy requires device calibration prior to NMBA and normalization of baseline readings.
EMG	Considered as accurate and reliable as MMG. Can be deployed in a wide variety of locations, including immobilized muscles.	Subject to electrical interference. Accuracy reduced by low muscle temperature. Greatest accuracy requires device calibration prior to NMBA.

Quantitative Monitors

- Tetragraph
- TwitchView
- TOFSCcan
- Be able to display PTC and TOFr in real time



Received: 29 May 2022 | Revised: 9 August 2022 | Accepted: 21 September 2022

DOI: 10.1111/cts.13429

ARTICLE

Reversal of rocuronium-induced intense neuromuscular blockade by sugammadex in Korean children: A pharmacokinetic and pharmacodynamic analysis

Sang-Hwan Ji[1,2] | Ki Young Huh[1,3] | Jaeseong Oh[1,3] | Hee-Jeong Jeong[1,2] | Young-Eun Jang[1,2] | Eun-Hee Kim[1,2] | Ji-Hyun Lee[1,2] | Jin-Tae Kim[1,2] | Hee-Soo Kim[1,2]

10-28% postoperative residual blockade(TOF<0.9) 6.5% severe block (TOF<0.7)

TOF-Watch SX accurate when calibrated , otherwise overestimate TOFratio

TOFscan, 3D, no calibration

Yhim et al. Perioperative Medicine (2021) 10:45 Perioperative Medicine

RESEARCH Open Access

Comparison of the TOFscan and the TOF-Watch SX during pediatric neuromuscular function recovery: a prospective observational study

- When using neuromuscular blocking agents (NMBA), quantitative NM monitoring is mandatory to optimize intubation time, monitor intraoperative muscle relaxation, determine adequate pharmacologic reversal agents, and reduce postoperative residual paralysis

Supinated palm, passively extended
Fixed to an arm board to ensure sole movement of adductor pollicis brevis
Clean with an alcohol swab
Skin surface allowed to dry
Two electrodes placed along the ulnar nerve
The negative (black) electrode at distal near the styloid process of radius
Positive electrode 3 cm proximally
Pediatric hand sensor
'to expand TOFscan's validity to infants and neonates, a smaller sensor is required'

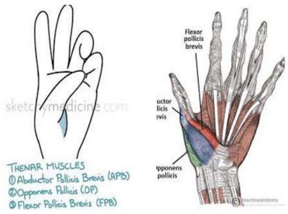
Perioperative Medicine

RESEARCH Open Access

Comparison of the TOFscan and the TOF-Watch SX during pediatric neuromuscular function recovery: a prospective observational study

ASPA 2023

Assessing 3D acceleration in children



- Unevitable Anatomical differences
- Shallow skin-to-nerve and nerve-to-nerve distance
- Individual differences in;
  - Distribution volume
  - Muscle mass
  - NMBA clearance
  - Age-dependent maturation of NM junction
- Contribute to differences In initial TOF raito
- Normalization adjusts the inherent TOF ratio

Pediatric Anesthesia

Pediatric Anesthesia 2010 20: 591–604

Neuromuscular block and current treatment strategies for its reversal in children

OLLI A. MERETOJA MD, PhD

- Use of neostigmin to reverse deep NMB will not be effective and will not result in adequate recovery, may result in recurarization
- Inadequate antagonism, subsequent fatigue rather than recurrence of block
- Recurarization may be seen clinically after using inadequate doses of sugammadex

Keep it Simple

- Easy -to understand interface
- Greater acceptance among clinicians
- Learning curve not steep

EDITORIAL

Neuromuscular Monitoring: Keep It Simple!

Mohamed Naguib, MD, MSc, FCARCSI,* and Aaron F. Kopman, MD†

Acquring the latest and most expensive quantitative monitor is not likely to solve the problem of undetected postoperative residual NMB

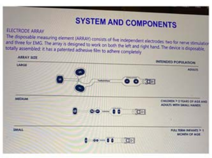
Postoperative Residual Weakness

- *Observing an unacceptable number of patients encountering respiratory distress in the recovery- 20-40% even reversed*
- *Pharyngeal dysfunction, increased risk for aspiration and pneumonia, acute respiratory events (hypoxemia, airway obstruction), need of tracheal intubation, discomfort for patients and surgeons, increased stay in PACU*
- *Using quantitative NMB Monitoring whenever a non-depolarizing muscle relaxant is used and documenting train of four in the anesthetic record*

NM MONITORING IS MANDATORY TO

- Optimize intubation time
- Monitor intraoperative muscle relaxation
- Determine adequate pharmacologic reversal agents
  - ***WFSA, SFAR recommend incorporating objective NM monitoring into daily practice***

Tips and Tricks



- Choose the appropriate monitoring device
- Familiarize yourself with the equipment
- Proper electrode placement
- Optimize skin preparation
- Monitor baseline values
- Individualize monitoring approach
- Consider the effect of temperature
- Avoid electrode movement
- Interpret the data carefully
- Monitor throughout the procedure
- Maintain communication
- Stay updated with guidelines and best practices

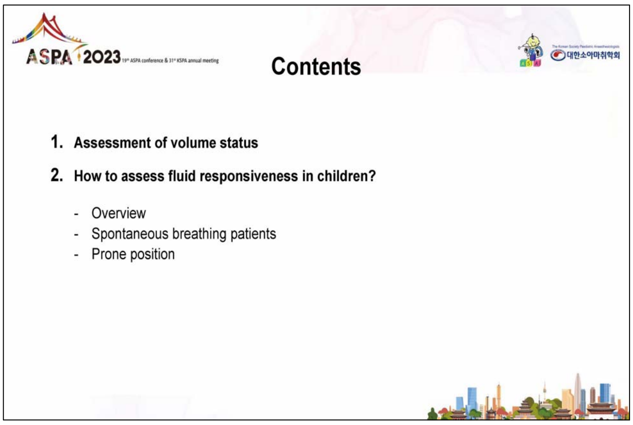
Take home

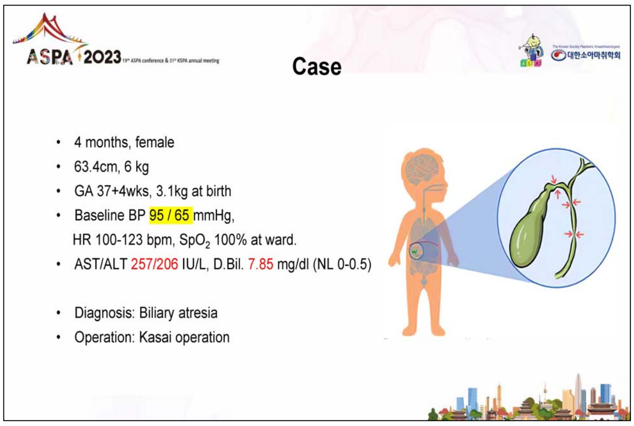
- Misconceptions
- Lack of knowledge
- Failure to follow well-established guidelines regarding the clinical use of NM drugs are commonplace
- What we need is not more complicated monitors, but the application of well- established lessons
- Rather the application of NMB and appropriate reversal

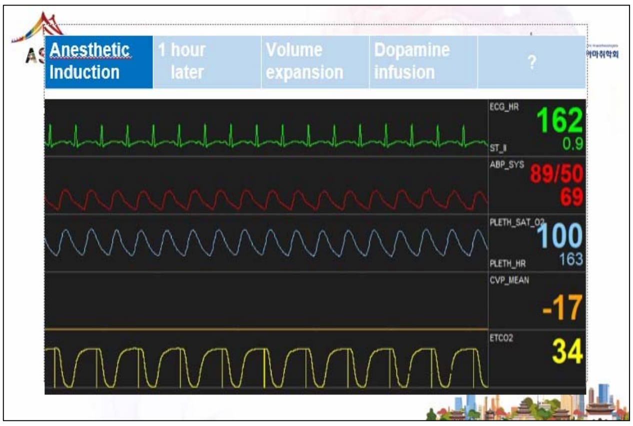
How to Assess Fluid Responsiveness in Children?

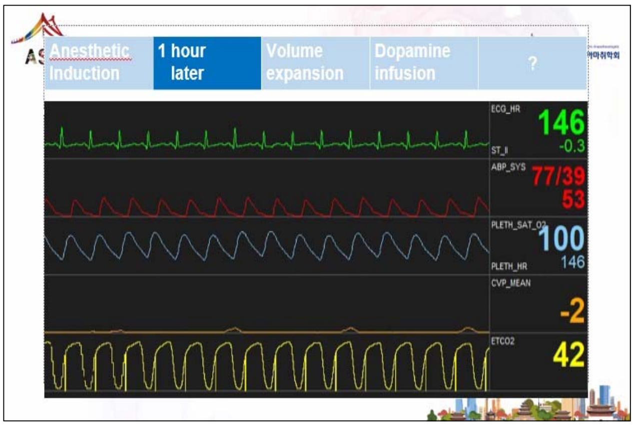
Eun-Hee Kim

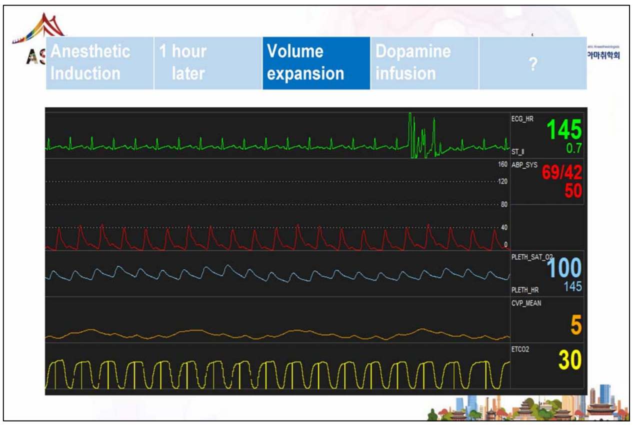
Seoul National University Hospital, Korea

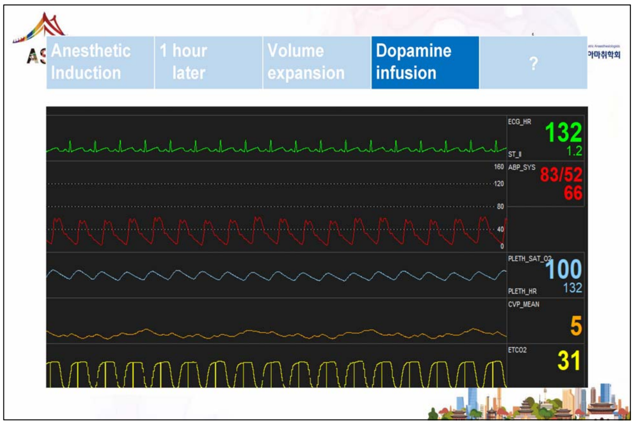


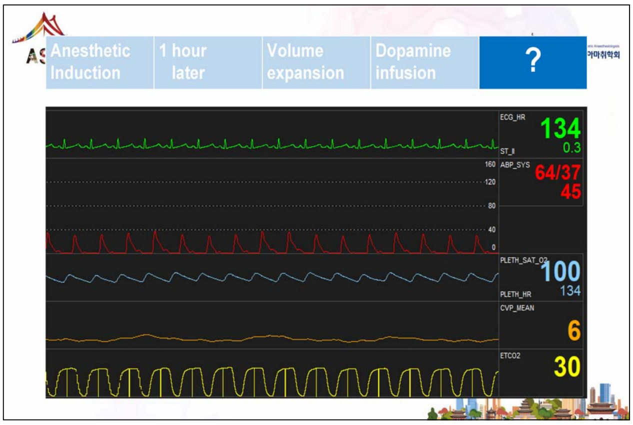


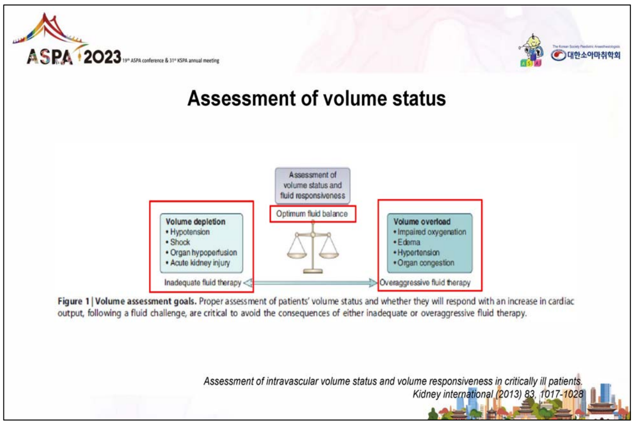


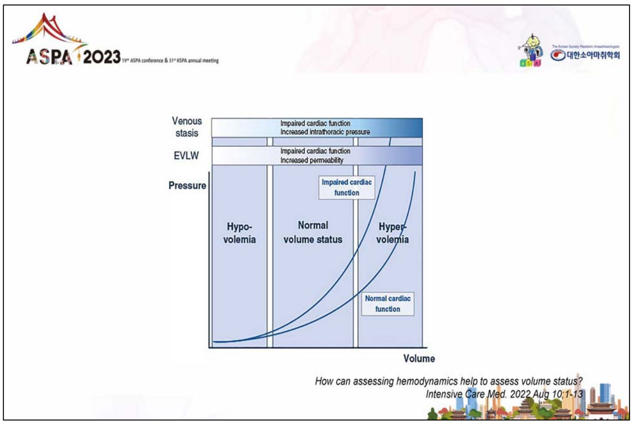


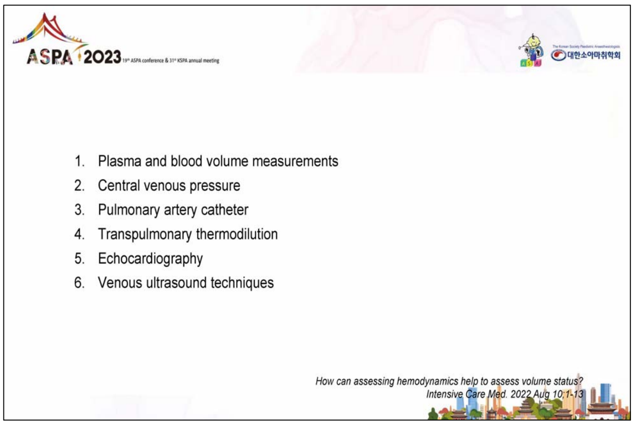


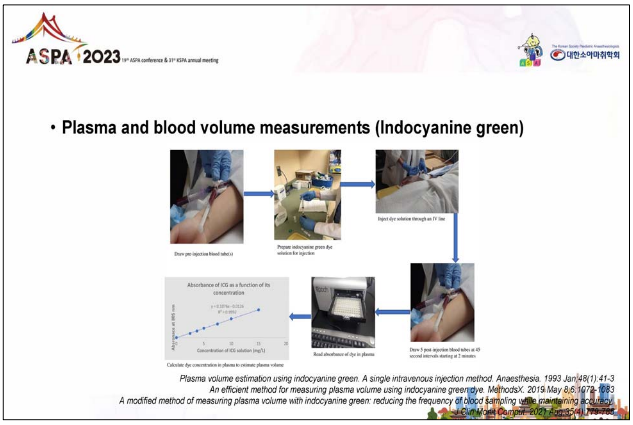

Anesthetic Induction
1 hour later
Volume expansion
Dopamine infusion
?
ECG_HR 132
ST_II 1.2
ABP_SYS 83/52 66
PLETH_SAT_O2 100
PLETH_HR 132
CVP_MEAN 5
ETCO2 31

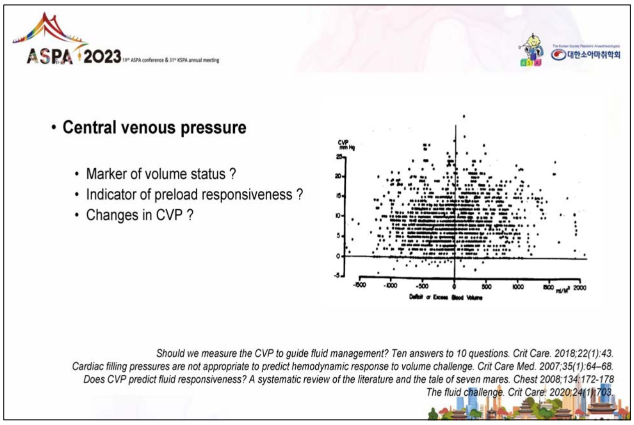

Anesthetic Induction
1 hour later
Volume expansion
Dopamine infusion
?
ECG_HR 134
ST_II 0.3
ABP_SYS 64/37 45
PLETH_SAT_O2 100
PLETH_HR 134
CVP_MEAN 6
ETCO2 30

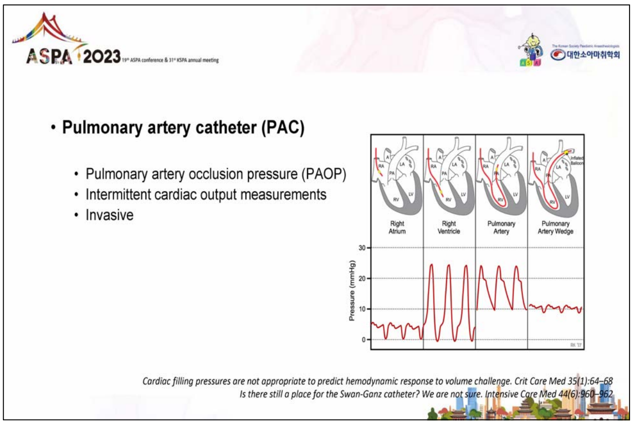

Assessment of volume status
Assessment of volume status and fluid responsiveness
Optimum fluid balance
Volume depletion
• Hypotension
• Shock
• Organ hypoperfusion
• Acute kidney injury
Volume overload
• Impaired oxygenation
• Edema
• Hypertension
• Organ congestion
Inadequate fluid therapy
Overaggressive fluid therapy
Figure 1 | Volume assessment goals. Proper assessment of patients' volume status and whether they will respond with an increase in cardiac output, following a fluid challenge, are critical to avoid the consequences of either inadequate or overaggressive fluid therapy.
Assessment of intravascular volume status and volume responsiveness in critically ill patients.
Kidney international (2013) 83, 1017-1028

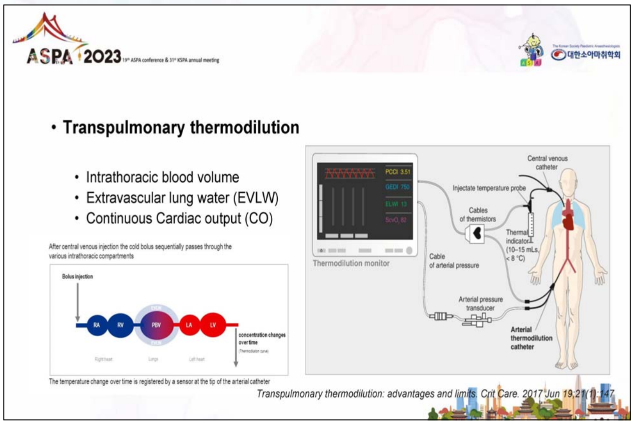

Venous stasis
Impaired cardiac function
Increased intrathoracic pressure
EVLW
Impaired cardiac function
Increased permeability
Pressure
Impaired cardiac function
Hypo-volemia
Normal volume status
Hyper-volemia
Normal cardiac function
Volume
How can assessing hemodynamics help to assess volume status?
Intensive Care Med. 2022 Aug 10;1-13

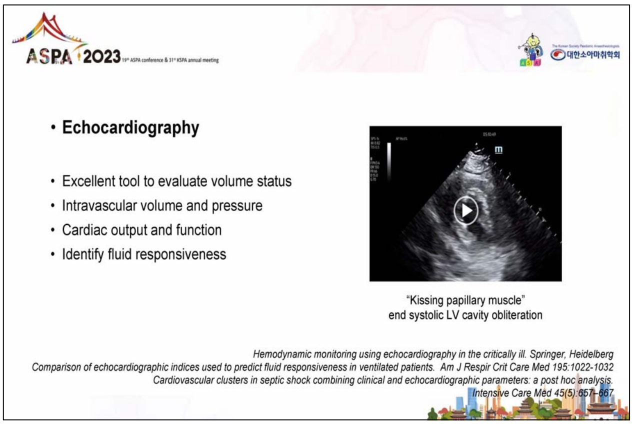

1. Plasma and blood volume measurements
2. Central venous pressure
3. Pulmonary artery catheter
4. Transpulmonary thermodilution
5. Echocardiography
6. Venous ultrasound techniques
How can assessing hemodynamics help to assess volume status?
Intensive Care Med. 2022 Aug 10;1-13

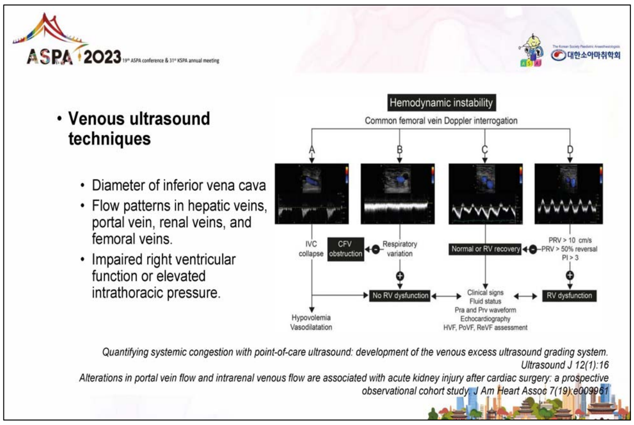

• Plasma and blood volume measurements (Indocyanine green)
Plasma volume estimation using indocyanine green. A single intravenous injection method. Anaesthesia. 1993 Jan;48(1):41-3
An efficient method for measuring plasma volume using indocyanine green dye. MethodsX. 2019 May 8;6:1072-1083
A modified method of measuring plasma volume with indocyanine green: reducing the frequency of blood sampling while maintaining accuracy.

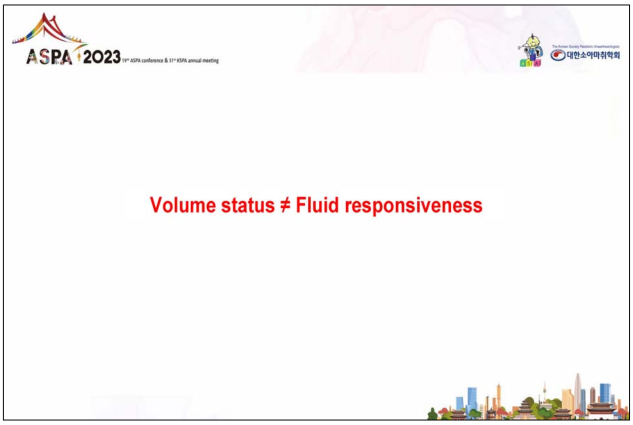

• Central venous pressure
• Marker of volume status ?
• Indicator of preload responsiveness ?
• Changes in CVP ?
Deficit or Excess Blood Volume
Should we measure the CVP to guide fluid management? Ten answers to 10 questions. Crit Care. 2018;22(1):43.
Cardiac filling pressures are not appropriate to predict hemodynamic response to volume challenge. Crit Care Med. 2007;35(1):64–68.
Does CVP predict fluid responsiveness? A systematic review of the literature and the tale of seven mares. Chest 2008;134:172-178
The fluid challenge. Crit Care. 2020;24(1):703.

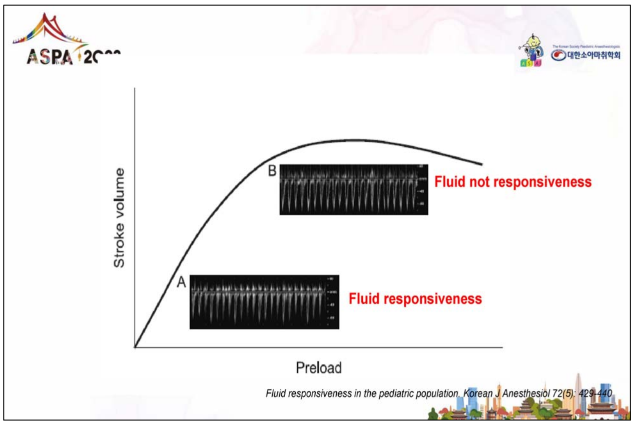

• Pulmonary artery catheter (PAC)
• Pulmonary artery occlusion pressure (PAOP)
• Intermittent cardiac output measurements
• Invasive
Right Atrium
Right Ventricle
Pulmonary Artery
Pulmonary Artery Wedge
Pressure (mmHg)
Cardiac filling pressures are not appropriate to predict hemodynamic response to volume challenge. Crit Care Med 35(1):64–68
Is there still a place for the Swan-Ganz catheter? We are not sure. Intensive Care Med 44(6):960–962

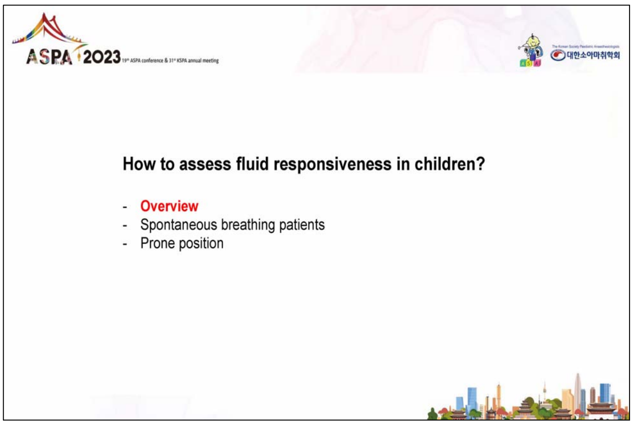

ASPA 2023
• Transpulmonary thermodilution
• Intrathoracic blood volume
• Extravascular lung water (EVLW)
• Continuous Cardiac output (CO)
After central venous injection the cold bolus sequentially passes through the various intrathoracic compartments
Bolus injection
RA
RV
PBV
LA
LV
The temperature change over time is registered by a sensor at the tip of the arterial catheter
Central venous catheter
Injectate temperature probe
Cables of thermistors
Thermal indicator (10–15 mL, < 8 °C)
Thermodilution monitor
Cable of arterial pressure
Arterial pressure transducer
Arterial thermodilution catheter
Transpulmonary thermodilution: advantages and limits. Crit Care. 2017 Jun 19;21(1):147

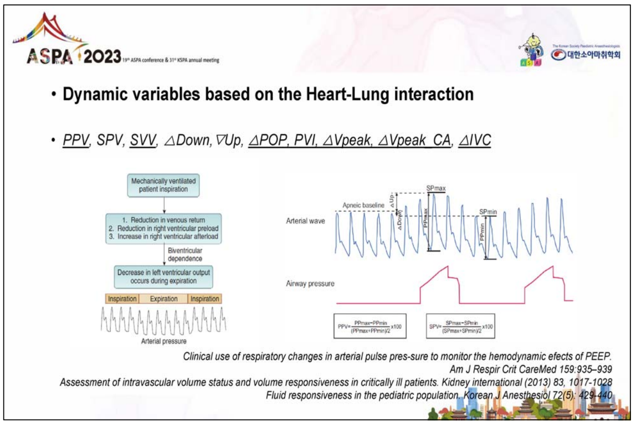

ASPA 2023
• Echocardiography
• Excellent tool to evaluate volume status
• Intravascular volume and pressure
• Cardiac output and function
• Identify fluid responsiveness
"Kissing papillary muscle"
end systolic LV cavity obliteration
Hemodynamic monitoring using echocardiography in the critically ill. Springer, Heidelberg
Comparison of echocardiographic indices used to predict fluid responsiveness in ventilated patients. Am J Respir Crit Care Med 195:1022-1032
Cardiovascular clusters in septic shock combining clinical and echocardiographic parameters: a post hoc analysis. Intensive Care Med 45(5):657–667

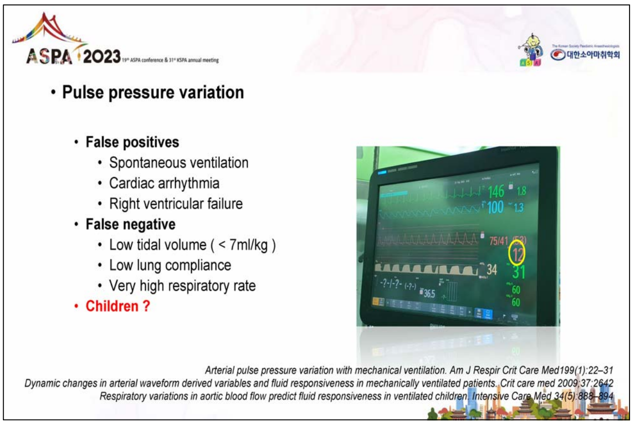

ASPA 2023
• Venous ultrasound techniques
• Diameter of inferior vena cava
• Flow patterns in hepatic veins, portal vein, renal veins, and femoral veins.
• Impaired right ventricular function or elevated intrathoracic pressure.
Hemodynamic instability
Common femoral vein Doppler interrogation
A
B
C
D
IVC collapse
CFV obstruction
Respiratory variation
Normal or RV recovery
PRV > 10 cm/s
PRV > 50% reversal
PI > 3
No RV dysfunction
Clinical signs
Fluid status
Pra and Prv waveform
Echocardiography
HVF, PoVF, ReVF assessment
RV dysfunction
Hypovolemia
Vasodilatation
Quantifying systemic congestion with point-of-care ultrasound: development of the venous excess ultrasound grading system. Ultrasound J 12(1):16
Alterations in portal vein flow and intrarenal venous flow are associated with acute kidney injury after cardiac surgery: a prospective observational cohort study. J Am Heart Assoc 7(19):e009961


ASPA 2023
Volume status ≠ Fluid responsiveness


ASPA
Stroke volume
B
Fluid not responsiveness
A
Fluid responsiveness
Preload
Fluid responsiveness in the pediatric population. Korean J Anesthesiol 72(5): 429-440


ASPA 2023
How to assess fluid responsiveness in children?
- Overview
- Spontaneous breathing patients
- Prone position

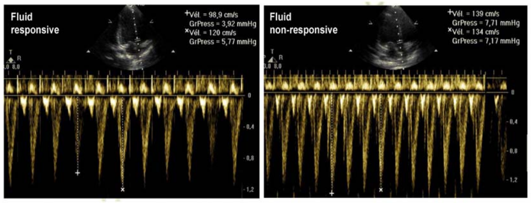

ASPA 2023
• Dynamic variables based on the Heart-Lung interaction
• PPV, SPV, SVV, △Down, ▽Up, △POP, PVI, △Vpeak, △Vpeak_CA, △IVC
Mechanically ventilated patient inspiration
1. Reduction in venous return
2. Reduction in right ventricular preload
3. Increase in right ventricular afterload
Biventricular dependence
Decrease in left ventricular output occurs during expiration
Inspiration
Expiration
Inspiration
Arterial pressure
Arterial wave
Airway pressure
Apneic baseline
SPmax
SPmin
Clinical use of respiratory changes in arterial pulse pres-sure to monitor the hemodynamic efects of PEEP. Am J Respir Crit CareMed 159:935–939
Assessment of intravascular volume status and volume responsiveness in critically ill patients. Kidney international (2013) 83, 1017-1028
Fluid responsiveness in the pediatric population. Korean J Anesthesiol 72(5): 429-440


ASPA 2023
• Pulse pressure variation
• False positives
• Spontaneous ventilation
• Cardiac arrhythmia
• Right ventricular failure
• False negative
• Low tidal volume (< 7ml/kg)
• Low lung compliance
• Very high respiratory rate
• Children ?
Arterial pulse pressure variation with mechanical ventilation. Am J Respir Crit Care Med199(1):22–31
Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients. Crit care med 2009;37:2642
Respiratory variations in aortic blood flow predict fluid responsiveness in ventilated children. Intensive Care Med 34(5):888–894

- Stroke volume variation
  - Vigileo monitor and FloTrac sensor
  - LiDCO plus system
  - LiDCO rapid system in children

Intraoperative fluid optimization using stroke volume variation in high risk surgical patients. Crit Care 2010;14:R118
Equipment review: an appraisal of the LiDCO plus method of measuring cardiac output. Crit care 2004; 8:190-195
Low predictability of three different noninvasice methods to determine fluid responsiveness in critically ill patients. Pediatr Crit Care Med 205;16:e89-94

- Respiratory variation of aortic blood flow peak velocity (△Vpeak)



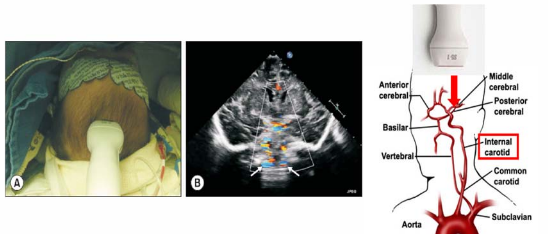
Respiratory variations in aortic blood flow predict fluid responsiveness in ventilated children. Intensive Care Med 34(5):888–894
Predicting fluid responsiveness in children: a systematic review Anesth Analg 117(6): 1380-1392
Point-of-care ultrasonography to predict fluid responsiveness in children: A systematic review and meta-analysis. Paediatr Anaesth. 2023 Jan;33(1):24-37. doi: 10.1111/pan.14574. Epub 2022 Oct 19. PMID: 36222022

- Respiratory variations of inferior vena cava

Fig. 20.41 Collapsible IVC >50%.

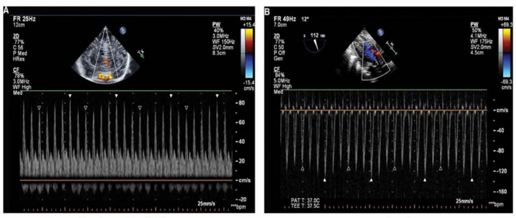
Fluid responsiveness in the pediatric population. Korean J Anesthesiol 72(5): 429-440
Inferior vena cava ultrasound, Monitoring, Smith's anesthesia for infants and children, 10th

- Respiratory variation of carotid artery blood flow peak velocity (△Vpeak_CA)



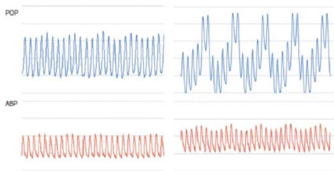
Respiratory Variation of Internal Carotid Artery Blood Flow Peak Velocity Measured by Transfontanelle Ultrasound to Predict Fluid Responsiveness in Infants: A Prospective Observational Study. Anesthesiology 130(5): 719-727

- Respiratory variation of carotid artery blood flow peak velocity (△Vpeak_CA)



Transfontanelle Ultrasound   Aorta

- △POP and PVI



Assessment of intravascular volume status and volume responsiveness in critically ill patients. Kidney international (2013) 83, 1017-1028
Assessment of dynamic variables of fluid responsiveness to predict desufflation-induced hypotension during paediatric laparoscopic surgery. Br J Anaesth. 2017 Nov 1;119(5):956-963

- △POP and PVI

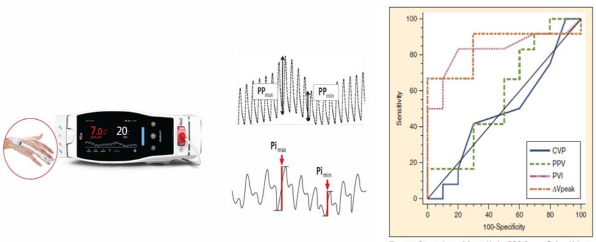
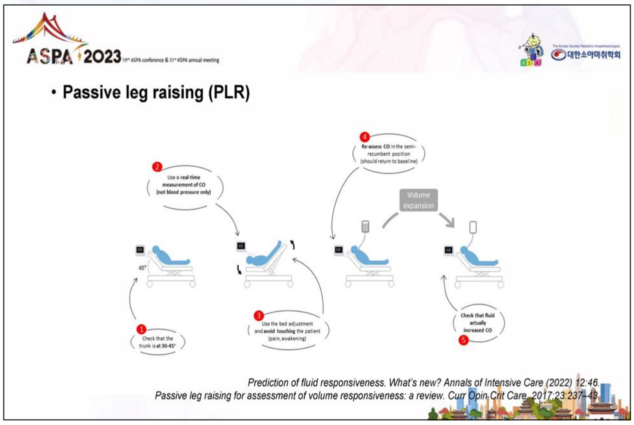


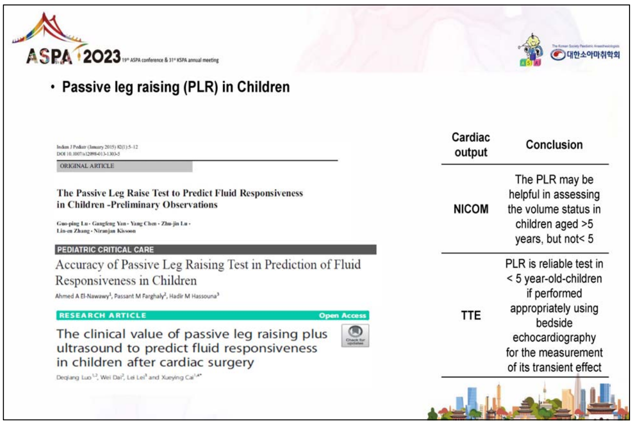
Fig. 18.3 Comparison of Areas Under ROC Curves Before Volume Expansion. Areas under the receiver operating curve (ROC) curve of

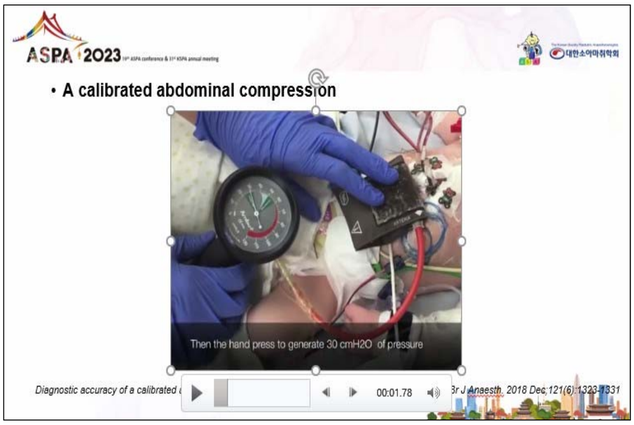
Does the plethysmographic variability index predict fluid responsiveness in mechanicall ventilated children? Br J Anaesth 2016;17:409-10
Systolic pressure variation, Monitoring, Smith's anesthesia for infants and children, 10th

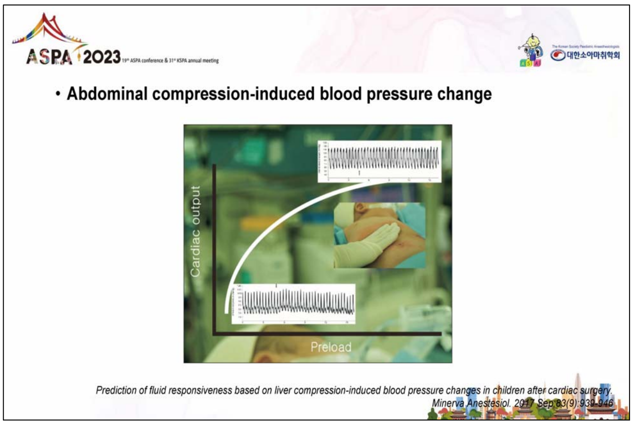
How to assess fluid responsiveness in children?

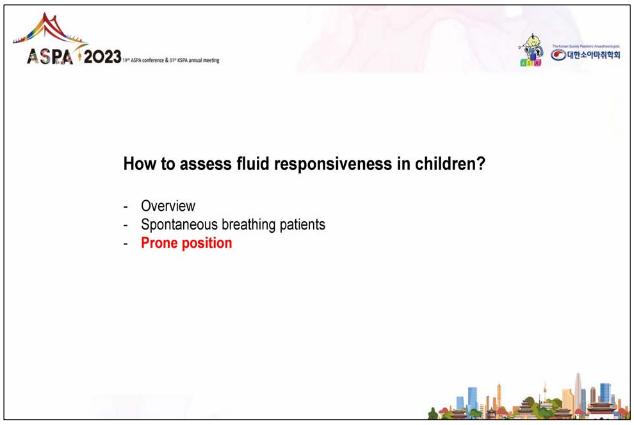
- Overview
- **Spontaneous breathing patients**
- Prone position

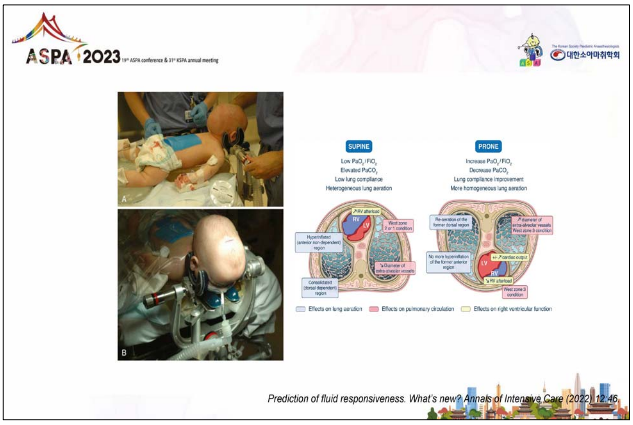

ASPA 2023
• Passive leg raising (PLR)
Volume expansion
Prediction of fluid responsiveness. What's new? Annals of Intensive Care (2022) 12:46
Passive leg raising for assessment of volume responsiveness: a review. Curr Opin Crit Care. 2017;23:237-43.

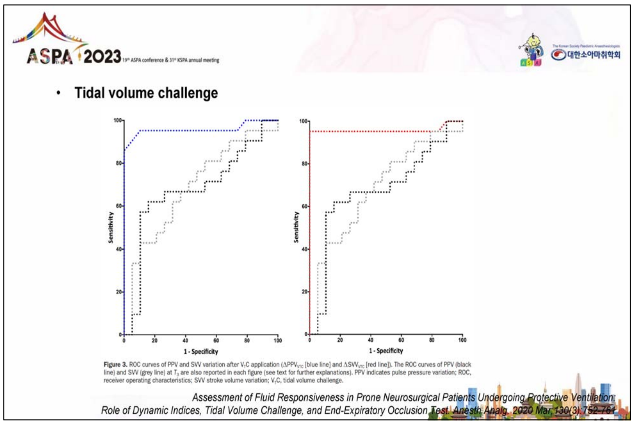

ASPA 2023
• Passive leg raising (PLR) in Children
The Passive Leg Raise Test to Predict Fluid Responsiveness in Children -Preliminary Observations
PEDIATRIC CRITICAL CARE
Accuracy of Passive Leg Raising Test in Prediction of Fluid Responsiveness in Children
RESEARCH ARTICLE
The clinical value of passive leg raising plus ultrasound to predict fluid responsiveness in children after cardiac surgery
Cardiac output | Conclusion
NICOM | The PLR may be helpful in assessing the volume status in children aged >5 years, but not< 5
TTE | PLR is reliable test in < 5 year-old-children if performed appropriately using bedside echocardiography for the measurement of its transient effect

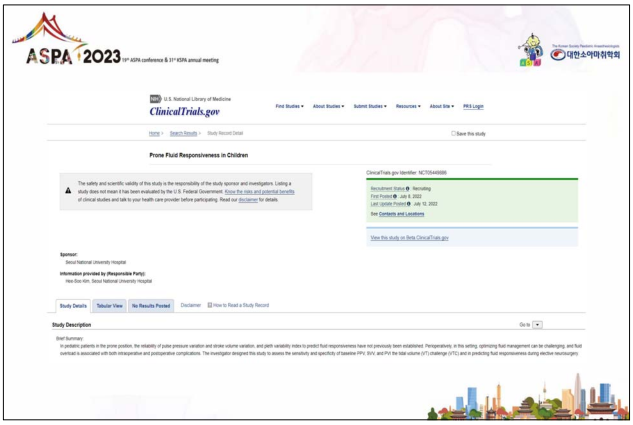

ASPA 2023
• A calibrated abdominal compression
Then the hand press to generate 30 cmH2O of pressure
00:01.78
Diagnostic accuracy of a calibrated
Br J Anaesth. 2018 Dec;121(6):1323-1331

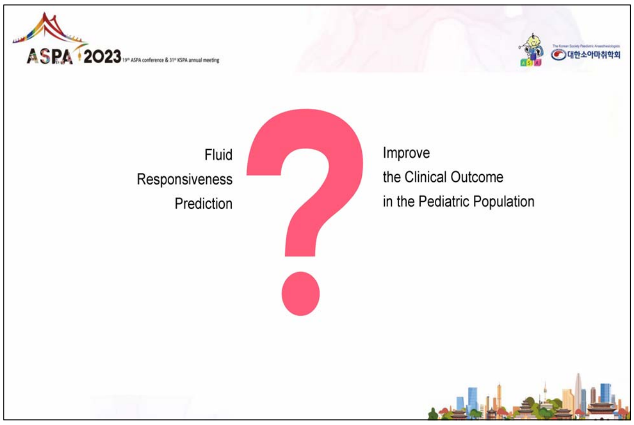

ASPA 2023
• Abdominal compression-induced blood pressure change
Cardiac output
Preload
Prediction of fluid responsiveness based on liver compression-induced blood pressure changes in children after cardiac surgery
Minerva Anestesiol. 2017 Sep;83(9):938-946

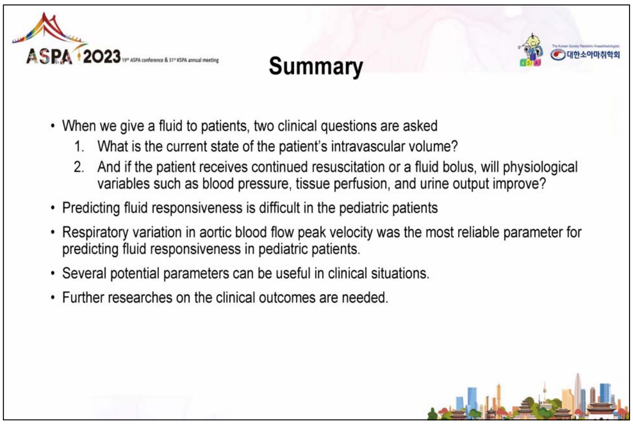

ASPA 2023
How to assess fluid responsiveness in children?
- Overview
- Spontaneous breathing patients
- Prone position


ASPA 2023
SUPINE
PRONE
Prediction of fluid responsiveness. What's new? Annals of Intensive Care (2022) 12:46


ASPA 2023
• Tidal volume challenge
Sensitivity
1 - Specificity
Assessment of Fluid Responsiveness in Prone Neurosurgical Patients Undergoing Protective Ventilation:
Role of Dynamic Indices, Tidal Volume Challenge, and End-Expiratory Occlusion Test. Anesth Analg. 2020 Mar;130(3):752-761


ASPA 2023
ClinicalTrials.gov
Prone Fluid Responsiveness in Children


ASPA 2023
Fluid
Responsiveness
Prediction
?
Improve
the Clinical Outcome
in the Pediatric Population


ASPA 2023
Summary
• When we give a fluid to patients, two clinical questions are asked
1. What is the current state of the patient's intravascular volume?
2. And if the patient receives continued resuscitation or a fluid bolus, will physiological variables such as blood pressure, tissue perfusion, and urine output improve?
• Predicting fluid responsiveness is difficult in the pediatric patients
• Respiratory variation in aortic blood flow peak velocity was the most reliable parameter for predicting fluid responsiveness in pediatric patients.
• Several potential parameters can be useful in clinical situations.
• Further researches on the clinical outcomes are needed.


ASPA 2023
Operating theatre in SNUH
Patient monitor_PPV
PVI, PSI, O3
LiDCO rapid_SVV, CI
Transfontanelle ultrasound_△Vpeak_CA

Session 3.

Sharing the Knowledge of NORA

Chair(s): Vivian Yuen (Hong Kong)

Yong-Hee Park (Korea)

Dexmedetomidine+ Remimazolam Clinical Applications and Limitations

Keira P. Mason

Boston Children's Hospital, Harvard Medical School, USA

Learning Objectives

- Understand the pharmacology and pharmacokinetic profile of Dexmedetomidine + Remimazolam
- Understand the clinical profile
- Review the relevant literature to aid in clinical delivery
- Share my clinical pearls

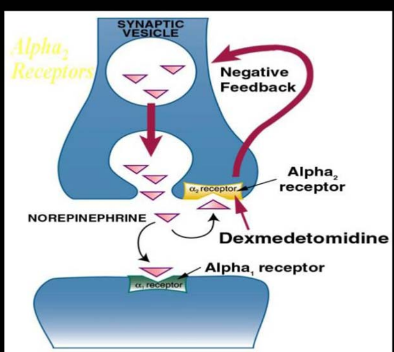
Dexmedetomidine Pharmacology

- α-2 to α-1 ratio of 1620:1
- intravenous, intramuscular, intranasal, sub cutaneous, epidural, transdermal routes
- Crosses blood-brain barrier
- CSF concentration is ~ 8% of the plasma concentration
- Inactive metabolites
- Half life 2-3 hours

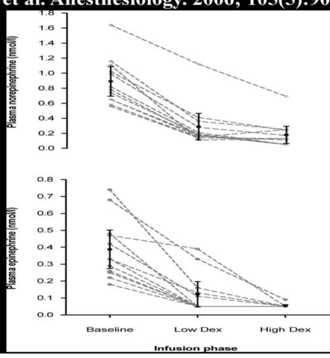
DEXMEDETOMIDINE

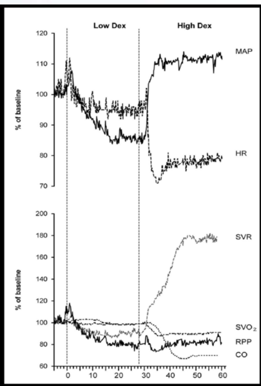
- 1999 approved for ICU
- 2008 approved for sedation
- Bolus 1 mcg/kg over 10 min
- Infusion 0.7 mcg/kg/hr
- 24 Hour Limit

2011
DEX approved in Europe
ICU approval only
NO time limit
Infusion no Bolus- 1.4 mcg/kg/hr



DEXMEDETOMIDINE
Effect on Epinephrine & Norepinephrine levels
Snapir et al. Anesthesiology. 2006; 105(5):902-10





Snapir et al. Anesthesiology. 2006; 105(5):902-10

Tolerable Rapid Bolus DEX Dose in Children

Dawes J. Ped Anes.2014

- Healthy children (5-9 yoa)
- Hemodynamic response
- + Response: ≥ 30% Δ mean HR,MAP
- 5 second bolus
- ED50 0.49 mcg/kg
- 50 second- max dec in median HR
- 100 second-median inc in median MAP

AVOID ANTICHOLINERGICS FOR BRADYCARDIA

Mason KP et al. AnesAnalg. 108;906-8:2009
Subramanyam R. Anesth Analg 2015

- All pediatric MRI
- Bradycardia Treatment-prospective (Mason et al)
- Prophylactic Tx –retrospective (Subramanyam et al.)
- Risk transient, marked or sustained hypertension

DEXMEDETOMIDINE EEG SIMULATES NON-REM SLEEP

Mason KP et al. Paediatr Anaesth. 2009 (12):1175-83
Mason KP et al. J Pediatr. 2012 (5):927-932

- DEX Sedation
- EEG resembles Stage II Sleep

Sea Lion

IM Sedation: Dex+Butorphanol+Versed

Courtesy of: William Van Boon, DVM
Marine Mammal Center, Sausalito, CA

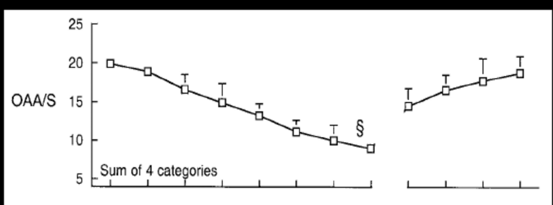
SEA LION

IM Sedation: Dex+Butorphanol+Versed

Courtesy of: William Van Bonn, DVM
Marine Mammal Center, Sausalito, CA

Depth of Sedation Increases with Increasing Dex

Ebert TJ et al. Anesth 2000



Dex is Not an Amnestic

Mason et al. BJA 2017

BJA

British Journal of Anaesthesia, 118 (2): 254–63 (2017)
doi: 10.1093/bja/aew421
Paediatrics

Feasibility of measuring memory response to increasing dexmedetomidine sedation in children

K. P. Mason[1,*], E. R. Kelhoffer[2,3], R. Prescilla[4], M. Mehta[2,3], J. C. Root[2,3,5], V. J. Young[1], F. Robinson[6] and R. A. Veselis[2,3]

BJA 2017

Dexmedetomidine pharmacodynamics in healthy volunteers: 2. Haemodynamic profile

P. J. Colin[1,2,*], L. N. Hannivoort[1], D. J. Eleveld[1], K. M. E. M. Reyntjens[1], A. R. Absalom[1], H. E. M. Vereecke[1] and M. M. R. F. Struys[1,3]

[1]Department of Anesthesiology, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands, [2]Department of Bioanalysis, Faculty of Pharmaceutical Sciences, Ghent University, Ghent, Belgium and [3]Department of Anaesthesia and Peri-operative Medicine, Ghent University, Ghent, Belgium

*Corresponding author. E-mail: p.j.colin@umcg.nl

Hemodynamics Predicted by [Dex]
HD as Marker of Sedation Depth

PJ Colin. BJA 2017

- N=18 healthy
- Step up dose of DEX (TCI)
- Hemodynamics described by serum [DEX]
- High correlation between sedation and HD
- Hemodynamics predict sedation/BIS depth
- PKPD Model for HR and MAP effects

Dexmedetomidine Sedation MRI, CT and Nuclear Medicine

Mason KP et al. Anes Analg 2006
Mason KP et al. Paediatr Anaesth. 2008
Mason KP et al..AnesAnalg. 108;906-8:2009
Mason KP et al. Paediatr Anaesth. 2009
Mason KP.AJR.2011
Mason KP et al. Radiology.2013
Mahmoud M. Pediatr Anesth 2014
Mahmoud M. J Clin Anesth 2013

- 2-3 mcg/kg bolus (10 min)-2 mcg/kg/hr
- Sedation Achieved: 8.9 ± 2.4 min
- Time to meet discharge criteria: 31.8 ± 18 min

Bioavailability

Anttila M. Br J Clinical Pharm. 2003
Iirola T. Eur J Clin Pharm 2011

- Oral- 16%
- Nasal- 65%
- Buccal- 82%
- Intramuscular-104%

DOI: 10.1111/pan.13202

Combination of intranasal dexmedetomidine and oral midazolam as sedation for pediatric MRI

Giorgio Cozzi[1], Lorenzo Monasta[1], Natalia Maximova[1], Federico Poropat[1], Andrea Magnolato[2], Eugenio Sbisà[2], Stefania Norbedo[1], Giuliana Sternissa[1], Davide Zanon[1], Egidio Barbi[1]

Institute for Maternal and Child Health IRCCS Burlo Garofolo, Trieste, Italy
[2]University of Trieste, Trieste, Italy

Intranasal dexmedetomidine, as midazolam-sparing drug, for MRI in preterm neonates

Jenny Bua[1], Marta Massaro[2], Francesca Cossovel[2], Lorenzo Monasta[1], Pierpaolo Brovedani[1], Giorgio Cozzi[1], Egidio Barbi[1,2], Sergio Demarini[1], Laura Travan[1]

[1]Neonatal Intensive Care Unit, Institute for Maternal and Child Health IRCCS Burlo Garofolo, Trieste, Italy
[2]University of Trieste, Trieste, Italy
Email: jenny.bua@burlo.trieste.it

WILEY Pediatric Anesthesia
2018 Aug;28(8):747-74

Pediatric Emergency Care

Intramuscular Dexmedetomidine, a Feasible Option for Children With Autism Spectrum Disorders Needing Urgent Procedural Sedation

Giorgia Carlone, MD; Andrea Trombetta, MD; Stefano Amoroso, MD — University of Trieste, Trieste, Italy — giorgiacarlone@gmail.com
Federico Poropat, MD — Emergency Department, Institute for Maternal and Child Health IRCCS Burlo Garofolo, Trieste, Italy
Egidio Barbi, PhD — University of Trieste, Trieste, Italy and Emergency Department, Institute for Maternal and Child Health IRCCS Burlo Garofolo, Trieste, Italy
Giorgio Cozzi, MD — Emergency Department, Institute for Maternal and Child Health IRCCS Burlo Garofolo, Trieste, Italy

PEDIATRICS/CASE REPORT

Intranasal Dexmedetomidine Sedation as Adjuvant Therapy in Acute Asthma Exacerbation With Marked Anxiety and Agitation

Giorgio Cozzi, MD; Sara Lega, MD; Rita Giorgi, MD; Egidio Barbi, MD

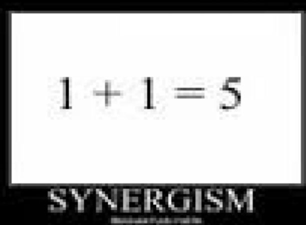
Pediatr Drugs (2017) 19:107–111
DOI 10.1007/s40272-017-0217-5

CURRENT OPINION

Intranasal Dexmedetomidine for Procedural Sedation in Children, a Suitable Alternative to Chloral Hydrate

Giorgio Cozzi[1] · Stefania Norbedo[1] · Egidio Barbi[1]

DEX is Synergistic
Narcotics, Propofol, Ketamine?



BioOne RESEARCH EVOLVED

CHEMICAL IMMOBILIZATION AND ANESTHESIA OF FREE-LIVING AARDVARKS (*ORYCTEROPUS AFER*) WITH KETAMINE-MEDETOMIDINE-MIDAZOLAM AND ISOFLURANE

Author(s): Benjamin Rey, Mary-Ann Costello, Andrea Fuller, Anna Haw, Robyn S. Hetem, Duncan Mitchell, and Leith C. R. Meyer
Source: Journal of Wildlife Diseases, 50(4):864-872.
Published By: Wildlife Disease Association
URL: http://www.bioone.org/doi/full/10.7589/2013-07-166

Proceeding of Veterinary and Animal Science Days 2018, 6th-8th June, Milan, Italy

International Journal of Health, Animal Science & Food Safety

Keywords: Ketamine, Norketamine, Dexmedetomidine, Pharmacokinetics, Tigers.

Corresponding Author: Federica Di Cesare

Pharmacokinetics of ketamine and norketamine following intramuscular administration combined with dexmedetomidine in tigers (*Panthera tigris*).

F. Di Cesare[1,*], P. Cagnardi[1], G. Ravasio[1], M. Capasso[3], W. Magnone[4], R. Villa[1]

[1] Department of Health, Animal Science and Food Safety, Università degli Studi di Milano, Via Celoria 10, 20133 Milan, Italy.
[2] Department of Veterinary Medicine, Università degli Studi di Milano, Via Celoria 10, 20133 Milan, Italy.
[3] Zoo of Naples, Via John Fitzgerald Kennedy 76, 80125 Naples, Italy.
[4] Parco Natura Viva - Garda Zoological Park, Loc. Figara 40, 36012 Bussolengo (Verona), Italy.

Veterinary Anaesthesia and Analgesia

SHORT COMMUNICATION

Immobilization of wild giant panda (*Ailuropoda melanoleuca*) with dexmedetomidine–tiletamine–zolazepam

Eur J Anaesthesiol, 2020

EJA — *Eur J Anaesthesiol* 2020; **37**:1–8

ORIGINAL ARTICLE

The synergistic effect of dexmedetomidine on propofol for paediatric deep sedation

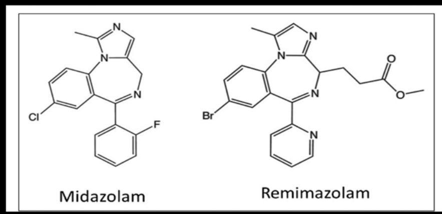
A randomised trial

Keira P. Mason, Raymond Seungjoon Park, Cornelius A. Sullivan, Karina Lukovits, Erin M. Halpin, Samantha T. Imbrescia, David Cavanaugh, Randy Prescilla and Victor L. Fox

Remimazolam

- A "soft drug"
- Goal is rapid biotransformation to inactive metabolites
- Ester modified benzodiazepine analog
- Eliminate the active metabolite (alpha hydroxy midazolam) of midazolam

Ester moiety added to midazolam



January 2020
Remimaz approved in Japan

- Approved for induction and maintenance of general anesthesia
- 12 mg/kg/hr until targeted level then 1-2 mg/kg/hr infusion
- 0.2 mg/kg bolus as needed

A placebo- and Midazolam-Controlled phase I Single Descending-Dose Study Evaluating the Safety, Pharmacokinetics, and Pharmacodynamics of Remimazolam (CNS 7056): Part I. Safety, Efficacy, and Basic Pharmacokinetics.

Antonik LJ. Anesth Analg 2012

- Phase 1 clinical trial, healthy adults
- Single, ascending dose study
- .01-.3 mg/kg bolus did not cause hypotension (SBP<80)
- Dose-dependant sedation (MOAA/S) scores] with remimazolam ≥ 0.05 mg/kg in a single ascending-dose study
- IV remimazolam 0.075–0.20 mg/kg similar sedation depth to 0.075 mg/kg midazolam
- More rapid recovery (5.5–20 vs 40 min)

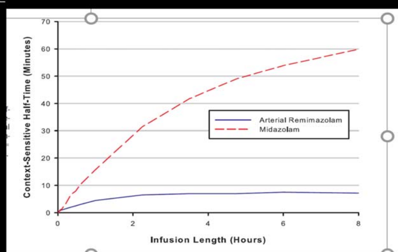
A placebo- and midazolam-controlled phase I single ascending-dose study evaluating the safety, pharmacokinetics, and pharmacodynamics of remimazolam (CNS 7056): Part II. Population pharmacokinetic and pharmacodynamic modeling and simulation

Wiltshire HR et al. Anesth Analg 2012

- A phase I, single-center, double-blind, active-controlled, randomized,single-dose escalation study
- n=54 healthy adults, 9 study groups, midaz groups and placebos
- Infusion of remimazolam (0.01–0.3 mg/kg)
- PK and PD study
- Max effect within 3 minutes

Remimaz phase 1 trials

Wiltshire HR et al. A placebo- and midazolam-controlled phase I single ascending-dose study evaluating the safety, pharmacokinetics, and pharmacodynamics of remimazolam (CNS 7056): Part II. Population pharmacokinetic and pharmacodynamic modeling and simulation. Anesth Analg 2012



Journal of Anesthesia, 2020

Efficacy and safety of remimazolam versus propofol for general anesthesia: a multicenter, single-blind, randomized, parallel-group, phase IIb/III trial

Matsuyuki Doi[1] · Kiyoshi Morita[2] · Junzo Takeda[3] · Atsuhiro Sakamoto[4] · Michiaki Yamakage[5] · Toshiyasu Suzuki[6]

Non inferiority study comparing Remimazolam to Propofol for induction and maintenance of GA

- **mean age 57**
- **6 or 12 mg/kg/hr Remimazolam until LOC then 1-2 mg/kg/hr maintenance titrated**
- **2-2.5 mg/kg propofol until LOC then 4-10 mg/kg/hr titrated**
- **Remimfentanil to both groups**
- **Primary endpoint- intraop awakening, recall, need for rescue, no body movements**

Non inferiority study comparing Remimazolam to Propofol for induction and maintenance of GA

- Efficacy rates were 100%
- Longer time to LOC (10–15 secs) and extubation (~ 6 min) in Remimazolam group
- No difference in adverse events
- Higher incidence of hypotension (20 vs 49%) with propofol
- 19% pain on injection with propofol, none with Remimazolam

Pharmacokinetics and Pharmacodynamics of Intranasal Remimazolam—a randomized controlled clinical trial

Marija Pesic. Europ j Clinical Pharm 2020

- Randomized, double-blind, 9-period cross-over design
- PK, PD, and safety
- Single intranasal doses of 10, 20, and 40 mg remimazolam (as powder or solution) vs. IN placebo and 4 mg IV remimazolam.
- IN remimazolam powder had a consistent absolute bioavailability of approximately 50%
- Tmax was 10min
- The higher doses of IN solution decreases relative bioavailability through swallowing and first-pass effect

A phase III study evaluating the efficacy and safety of remimazolam (CNS 7056) compared with placebo and midazolam in patients undergoing colonoscopy

Douglas K. Rex, GI Endoscopy 2018

- N=461 randomized patients in 12 U.S. sites
- Gastroenterologist delivered
- Less hypotension
- The primary endpoint was met for remimazolam, placebo, and midazolam in 91.3%, 1.7%, and 25.2% of patients,
- Faster recovery

Remimazolam vs Propofol in Upper Gastrointestinal Endoscopy: A Multicenter, Randomized, Non-inferiority, Phase III trial

Shao-Hui Chen. J Gastroent and Hepatology 2020

- Phase 3 trial- China
- n-384
- Longer time to sedate ~ 1 min
- Shorter recovery ~ 1 min
- Less treatment requiring hypotension (0.5 vs 5.8%)
- Less respiratory depression (1.0 vs 6.8%)
- Fewer adverse events (39 vs 60%)

Deeper Sedation Induced With Propofol

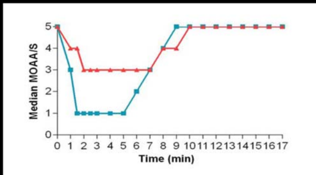


FIGURE 3 Sedation profile. MOAA/S, Modified Observer's Assessment of Alertness/Sedation. —■—, Remimazolam tosilate; —■—, Propofol.

Remimazolam vs Propofol Benefits of Flumazenil

W Luo et al. BMC Anesthesiology 2023

- Prospective RCT
- N=115
- Remimazolam, Remimazolam+Flumazenil, Propofol
- Similar induction time
- Similar recovery between Propofol and Remimazolam+Flumazenil (12 min)
- Less hypotension with Remimazolam (32 vs 68%)
- Less ephedrine and phenylephrine
- Less injection pain

Journal of gastroenterology and hepatology, 2021

Effect of Remimazolam Tosilate on Early Cognitive Function in Elderly Patients undergoing Upper Gastrointestinal Endoscopy

Tan Yingjie, Ouyang Wen, Tang Yongzhong, Fang Ning, Fang Chao, Quan Chengxuan

First published: 14 December 2021 | https://doi-org.ezp-prod1.hul.harvard.edu/10.1111/jgh.15761

- 100 mcg/kg Remimazolam compared to 1-1.5 mg/kg propofol
- No difference in cognitive testing 5 minute post recovery
- Less hypotension (3% versus 48%)
- Average age 66
- Same average recovery 4 minutes

Psychomotor Recovery Following Remimazolam Induced Sedation and the Effectiveness of Flumazenil as an Antidote

Xia Chen. Clinical Therapeutics 2020

- 87 healthy Chinese
- Phase 1a and 1b trial
- Double blind randomized- midaz vs remi
- 2 hr infusions (BIS 40-60)
- subjects fully alert median 3.5 min after injection of flumazenil, compared with 35 min after

Memory Storage Affected
Xia Chen. Clinical Therapeutics 2020

- 20 min verbal word learning test
- Normal responses at 1.5-2 hrs post consciousness
- Diminished word recall at 4 hrs post
- No difference in recall with flumazenil

Dosing and Lablling Worldwide

- Europe, USA and China: procedural sedation
  – 5 mg IV bolus over 1 min and then 2.5 mg bolus rescue In Japan and
- South Korea: general anesthesia
  –infusion rate for induction of 12 mg/kg/hour (adjustable)
  –1 – 2 mg/kg/hour, maintenance

When you're curious, you find lots of interesting things to do
- **Walt Disney**

Needle Free
Procedural Sedative Techniques in Pediatric Patients

Jurgen C. de Graaff

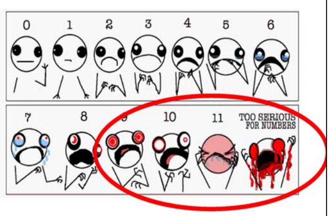
Department of Paediatric Anesthesia, Erasmus MC University Medical Center Rotterdam, Netherlands

The main goals of safe pediatric PSA

- to reduce and minimize the child's **fear and anxiety**
- to reduce **discomfort and pain** connected with procedures
- to minimize **psychological trauma** (which may include amnesia)
- to control the child's **behavior and movement** for safe and successful completion of the procedure
- to protect the child's **safety during** the procedure and afterwards
- to ensure **safe discharge** from care

Zielinska Ped Anesth 2022; 29:583–590.

Why needle free?



Needle free? = non-invasive?

- No pain at application medication:
  - Intravenous
  - Intra muscular medication
- No use of invasive airway
  - Supraglotic airway devices: laryngeal mask of guedell/mayo
  - Tube

Needle free methods

- Non-pharmaceutical
- Pharmaceutical methods

Non-pharmaceutical interventions

Bray et al. Insights into Imaging (2022) 13:146
https://doi.org/10.1186/s13244-022-01278-5

Insights into Imaging

CRITICAL REVIEW — Open Access

Interventions and methods to prepare, educate or familiarise children and young people for radiological procedures: a scoping review

Lucy Bray[1*], Lisa Booth[2], Victoria Gray[3], Michelle Maden[4], Jill Thompson[5] and Holly Saron[1]

Non-invasive interventions

- **Information**

Prepare, educate or familiarize children

- **Distraction**

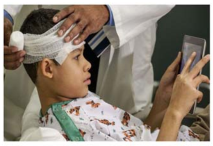
Non-invasive interventions

- **Information**

Prepare, educate or familiarize children

- Information: video, colour book, photo-diary booklet, story-book, meet staff and environment
- Technology: Music, Smartphone applications, Interactive videos, Animations, Virtual reality

- **Distraction**



Hoxhallari, Plastic and reconstructive Surgery 2019

Felemban BMC Oral Health 2021

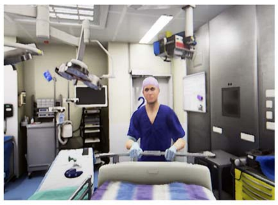
Non-invasive interventions

- **Information**

Prepare, educate or familiarize children

- Information: video, colour book, photo-diary booklet, story-book, meet staff and environment
- Technology: Music, Smartphone applications, Interactive videos, Animations, Virtual reality: **preperation**

- **Distraction**



Eijlers Eur J Anaesthesioly 2019

SYSTEMATIC REVIEW

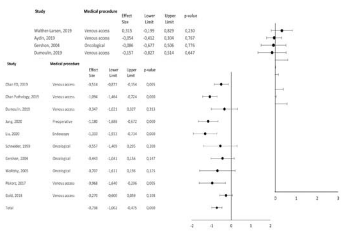
Pediatric Anesthesia WILEY

Virtual reality in pediatrics, effects on pain and anxiety: A systematic review and meta-analysis update

Floris Q. Tas* | Cynthia A. M. van Eijk* | Lonneke M. Staals | Jeroen S. Legerstee | Bram Dierckx

Reduction on

- Pain +
- Anxiety +



Non-invasive interventions

- **Information**

Prepare, educate or familiarize children

- Information: video, colour book, photo-diary booklet, story-book, meet staff and environment
- Technology: Music, Smartphone applications, Interactive videos, Animations, Virtual reality
- Facilitate play

- **Distraction**

- Provision of information: play specialists/child life specialists, nurse, paediatrician, medical social worker, volunteers, child life specialist etc.
- Opportunities to practice: Mock scanner
- **Feed and Swaddle < 6 months**

Definitions of drug-induced sedation

- **Minimal sedation** calming of the child and reduction of fear during which the patient is conscious and responds normally
- **Moderate sedation** depression of consciousness during which the patient is sleepy but responds purposefully to verbal commands or light tactile stimulation
- **Deep sedation** depression of consciousness during which the patient is asleep and cannot be easily roused but does respond to repeated or painful stimulation (may required assistance to maintain a patent airway and spontaneous ventilation)
- **General anesthesia**

Needle free sedation:

- **Minimal sedation** calming of the child and reduction of fear during which the patient is conscious and responds normally
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- **General anesthesia**

SPECIAL INTEREST ARTICLE

WILEY Pediatric Anesthesia

Safe pediatric procedural sedation and analgesia by anesthesiologists for elective procedures: A clinical practice statement from the European Society for Paediatric Anaesthesiology

Marzena Zielinska[1] | Alicja Bartkowska-Sniatkowska[2] | Karin Becke[3] | Claudia Höhne[4] | Nadia Najafi[5] | Eva Schaffrath[6] | Dusica Simic[7] | Maria Vittinghoff[8] | Francis Veyckemans[9] | Neil Morton[10]

Zielinska Ped Anesth 2019;29:583–590

Purpose sedation: Assess requirements?

- Cooperation
- Reduced awareness
- Lack of movement
- Duration
- Analgesia
- Anxiolysis
- Fear reduction
- Movement
- Required depth
- Emergence
- Location

Zielinska Ped Anesth 2019;29:583–590

Assessment for PSA

- Medical status and past medical history
- Current comorbidities and surgical problems
- Psychological and developmental status
- Past sedation and anesthesia history including family history
- Current and previous medication, nutraceuticals
- Allergies
- Age, weight, and height
- Focused examination of: **airways**, lungs and heart
- Increased risk for complications: **Airway**!
- Urgency of the procedure
- Fasting status; elective — 6h: solid meal (**not for minimal sedation: level 1**)
  - 4h: milk/light meal
  - 3h: breast milk
  - 1h (0?): clear liquids

Zielinska Ped Anesth 2019;29:583–590
Eur J Anaesthesiol 2022; 39:4–25

Consult specialist!

- Increased intracranial pressure
- Risk of aspiration: esophageal disease, polyhandicap, duration of fasting for solids and liquids
- Difficult airway due to anatomical or functional problems! (hypotonia,obstructive sleep apnea?)
- Respiratory compromise
- ASA-PS III or greater
- Young age, especially infants (birth to age 1 year)
- Severe anxiety
- Autism spectrum disorder
- Developmental delay

Zielinska Ped Anesth 2019;29:583–590

Preperation

Information and consent
- Patient and parents
- Risks
- Benefits
- Alternatives

Psychological preparation
- Developmental stage
- Expectations from parents

Requirements healthcare professionals:

Knowledge & skils
- Pediatric PSA drug pharmacology
- Assessment of children
- Monitoring of children
- Recovery care of children!
- Pediatric PSA complications:
  - advanced pediatric life support
  - **airway management**

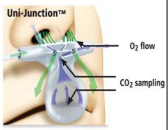
Practical
- Effectively delivering PSA technique
- Using, interpreting, and responding to monitoring equipment
- Managing its complications
- Observing clinical signs in children
  - airway patency, breathing rate and depth, pulse, pallor and cyanosis, and depth of sedation
- Using, interpreting, and responding to monitoring equipment

Facilities and equipment

- Pulse-oximeter
- ECG
- NIBP
- Oxygen supply and delivery equipment
- Capnography
- Oral or nasopharyngeal airway
- Face masks and other suitable supraglotic airway devices
- Bag with self-inflating reservoir
- Endotracheal tubes & laryngeal masks
- Laryngoscope
- **Suction device!**
- Emergency medication
  - atropine, epinephrine, dopamine, flumazenil, naloxone, muscle relaxant, neostigmine, local anesthetics, sugammadex, calcium, glucose 10%, balanced electrolyte solution
- Intravenous catheters/lines/infusion pumps
- Thermometer/active warming system
- **Easily available**: blood gas analysis, blood glucose measurements, intraosseous needles and defibrillator

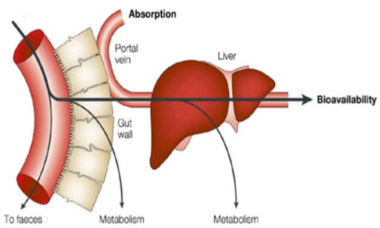
Monitoring and documentation

Moderate sedation	Deep sedation
Pulse oximetry	Pulse oximetry
Heart rate	Heart rate
Respiratory rate	ECG
Strongly recommended:	Respiratory rate
ECG	Blood pressure
End-tidal carbon dioxide/ capnography	End-tidal carbon dioxide/ capnography



Needle free pharmaceutical methods : Routes of application

- Oral & rectal: bioavailability: 0-100%
  - Non-invasive?

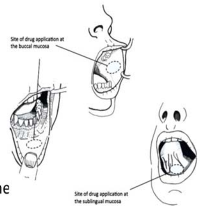


Needle free pharmaceutical methods : Routes of application

- Oral & rectal
- **Nasal**
  - **Atomizer**
  - **Max: 0,3 ml per dose !!!**

Needle free pharmaceutical methods : Routes of application

- Oral & rectal
- **Nasal**
- **Buccal: swallow!**
- **Inhalation: nitrous oxide**
- Transdermal
  - Topical anesthesia for lacerations: lidocaine, adrenaline
  - Tissue adhesive for laceration repair: dermabond



Chloral hydrate (CH)

- Discovered in 1832, administered to children since 1869
- Most widely used: imaging studies
- Dose & onset time & duration of action
  - Oral & rectal: good absorption!
  - 50-100 mg/kg; 30-60 min; 2-8 h & 24 h
  - Elimination half-life:
    - Children: 4-12 h
    - Infants: 28 h
    - Preterm: 37h
- Side effects: oxygen desaturation
- Adverse event:
  - Case repots serious respiratory depression!
  - Significant morbidity and even death following procedural sedation
  - In patients with significant respiratory illness!
- Anesthesiologists: Do not use!
- Safe and short-acting alternatives

Midazolam

- **Oral, nasal, buccal**, rectal
- 0.25, 0.5, 0.75, or 1 mg/kg
- Onset time: 10-45 min
- Duration of action: 45-60 min
- Eliciting paradoxical reactions:
  - dysphoria, inconsolable violent crying, agitations, struggling needing restraint, disorientation, restlessness: 1-5%
- Non-responders, despite adequate plasma concentrations
- pH: 3.5! Acid and irritating!
  - => Ozalin/ADV6209: wild orange & sucrose registered 2018 EU 6 – 17 yrs; 0,25 mg/kg

Williamson Drugs & Therapy Persp 2019

(Es-)Ketamine

- Bioactivity & dose:
  - Oral: 20%,
  - Rectal: 25%
  - Nasal: 50%; 0.5-2.0 - 5 mg/kg
- Analgesic!
- Side effects:
  - oxygen desaturation (90%)
- Adverse events: Hypersalivation, bradycardia, drowsiness, dysphoria/dissociation, unpleasant taste, dizziness, nausea/vomiting, vision changes, laryngospasm: 0.3%, apnea: 0.8%

Green Ann Emerg Med 2009
Alanazi Am J Emerg med 2022

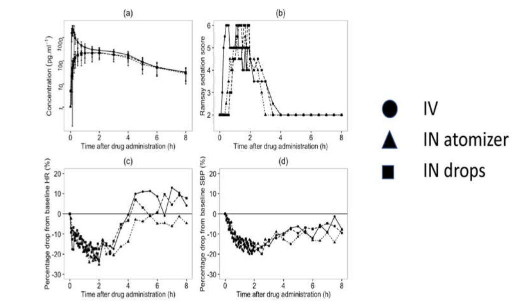
Dexmedetomidine

- Alpha 2 receptor agonist
- Bioactivity & dose & onset – duration time:
  - Oral: 16%
  - Buccal: 82%; 1-3 μg/kg; 20-40 min
  - Nasal: 65%; 1-3 μg/kg; 20-40 min
- Side effects
  - Bradycardia, desaturation,
  - Anticholinergic reactions
  - Easily wake up
- Contraindications: digoxin, beta blockers, amiodarone, calcium channel blockers or other medications predispose bradycardia or hypotension

Pharmacokinetic and pharmacodynamic study of intranasal and intravenous dexmedetomidine

A. Li[1,11], V. M. Yuen[2,7,11], S. Goulay-Dufay[1,8,11], Y. Sheng[3,9], J. F. Standing[4,*], P. C. L. Kwok[1,5,*], M. K. M. Leung[6], A. S. Leung[6], I. C. K. Wong[1,10] and M. G. Irwin[2]

British Journal of Anaesthesia, 120 (5): 960-968 (2018)



Nitrous oxide

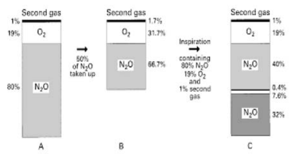
- Inhalation anesthetic: “laughing gas,”
- Discovered in 1772, first used in 1884 for dental extractions

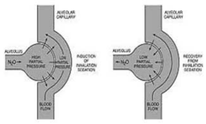
Nitrous oxide

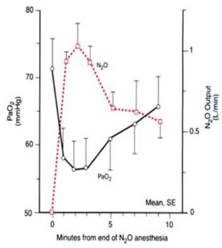
- Inhalation anesthetic: “laughing gas,”
- Discovered in 1772, first used in 1884 for dental extractions
- Concentration effect => diffusion hypoxia!

Concentration effect (second gas effect)
Diffusion hypoxia = Fink effect

Minimum: 30% oxygen & 70% N_2O
Entonox: 50% oxygen & 50% N_2O

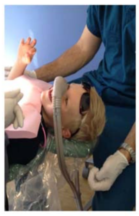






Nitrous oxide

- Inhalation anesthetic: "laughing gas,"
- Second gas effect: diffusion hypoxia!
- Popular
  - pediatric dentists
  - Emergency room: fractures
- Success dependent on: temperament
- Lower success: mental disabilities
- Adverse events: vomiting!



Painful procedures in emergency room

- Distraction: telephone app / video/VR
- Inhalation Nitrous oxide
- (Es) ketamine: intranasal

Radiologic procedures

- Distraction & education:
  - mock scanner: > 6 – 9 yrs
  - Feed and swaddle: < 6 months

ORIGINAL ARTICLE

Experience with a "Feed and Swaddle" program in infants up to six months of age

Leah B. Templeton[1] | Michael J. Norton[1] | Eduardo J. Goenaga-Díaz[1] | Douglas H. McLaughlin[1] | Michael E. Zapadka[2] | T. Wesley Templeton[1]

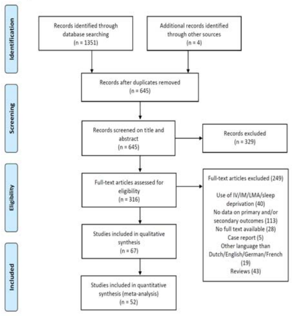
	% Overall	Median ASA status	Median day of life at time of scan (Range)	Median weight kg (Range)	Mean length of scan (min)	Non-contrast	Contrast	Outpatient	Inpatient
<90 d; n = 124									
Diagnostic (95% CI)	91.1% (113/124) (84.8%-95.0%)	3	30 (1-88)	4.0 (2.0-6.4)	39 ± 22	89.1% (82/92)	96.9% (31/32)	93.8% (30/32)	90.2% (83/92)
Nondiagnostic	8.9% (11/124)	3	53 (3-87)	4.6 (3.2-5.4)	52 ± 23	10.9% (10/92)	3.1% (1/32)	6.2% (2/32)	9.8% (9/92)
≥90 d; n = 40									
Diagnostic (95% CI)	95.0% (38/40) (83.5%-98.6%)	2	118 (90-174)	6.3 (4.1-9.5)	36 ± 20	96.6% (28/29)	90.9% (10/11)	92.3% (12/13)	96.3% (26/27)
Nondiagnostic	5.0% (2/40)	2	153 (126-179)	6.1 (4.8-7.3)	57 ± 61	3.4% (1/29)	9.1% (1/11)	7.7% (1/13)	3.7% (1/27)

< 6 Months

Acta Anaesthesiol Scand. 2020;64:63–68.

Needle-free pharmacological sedation techniques in paediatric patients for imaging procedures: a systematic review and meta-analysis

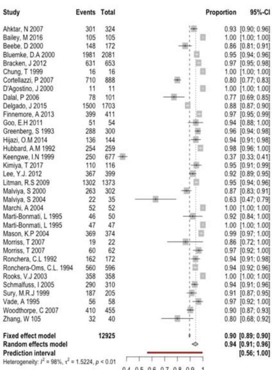
Ingeborg de Rover[1,†], Jasper Wylleman[1,3,†], Jaap J. Dogger[1], Wichor M. Bramer[2], Sanne E. Hoeks[1] and Jurgen C. de Graaff[1,*]



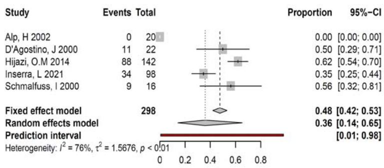
British Journal of Anaesthesia, 130 (1): 51e73 (2023)

Choral hydrate

- pooled proportion of success of 0.94 (95% CI, 0.91-0.96)

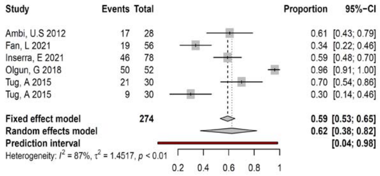


Midazolam oral/IN/rectal



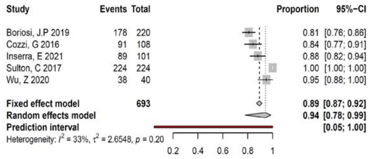
- Pooled proportion of success of 0.36 (95% CI, 0.14-0.65)
- Onset time was 53±41 minutes,
- Sedation lasted 59-76 minutes.
- Recovery time was reported as 113±48 minutes.

Dexmedetomidine IN: 2-4 µg/kg



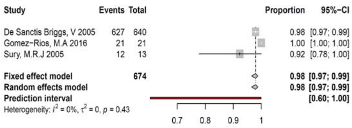
- Pooled proportion of success of 0.62 (95% CI, 0.38-0.82)
- >20% decrease in baseline heart rate
- 10% experienced bradycardia
- 3% oxygen desaturation.

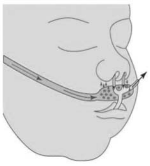
Dexmedetomidine: 3µg/kg & midazolam: 0.3mg/kg



- Pooled proportion of success: 0.94% (95% CI, 0.78-0.99)
- Onset time: 9-39 min.
- Sedation duration: 58-118 min.
- Recovery time: 61-91 min.
- Nausea and vomiting 2-5% — Hypotension: 3%
- Bradycardia in 6-8% — Oxygen desaturation: 3-5%,

Sevoflurane





- Pooled proportion of success of 0.98 (95% CI, 0.97-0.99)
- 1 MAC sevoflurane = anesthesia
- No proper airway management => not Safe

Do not use!

Conclusion Radiologic procedures

- Distraction & education: mock scanner & feed and swaddle
- Intranasal:
  - Dexmedetomidine 3µg/kg & midazolam 0.3 mg/kg
- IV contrast!
  - Selection of patients
- Parents love it!
- General anesthesia easier faster and 100% succes ☹

Conclusion:

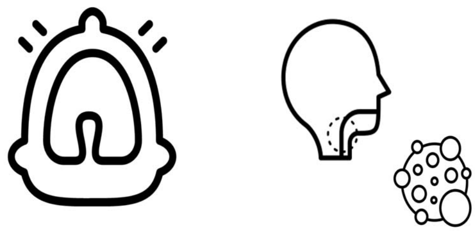
- Adequate medication
- Adequate dose
- Route of application
- Parents compliance!
- Full examination: airway
- Airway skills
- Adequate monitoring
- Adequate recovery facilities
- Adequate time

- Painful procedures
  Nitrous oxide
  IN: Esketamine 0.5-2mg/kg
- Radiologic procedures
  - < 6 months: feed & swadle
  - > 6 – 9 yrs: mock scanner
  Other ages
  - IN: Dexmedetomidine 3µg/kg & midazolam 0.3 mg/kg
  - (Sevoflurane + IV + LMA)

How to Deal with Challenging Sedation Cases

Eun-Young Joo

Asan Medical Center, Korea



CASE 1

- 15/M
- 166.5cm/50.4kg
- EEG for Epilepsy
- Known Autism
- No snoring or history of sleep apnea
- Recurrent Hx. of failed sedation
- PR 98 SpO_2 100% on Room air

- VIMA with Sevoflurane, accompanying security agents
- IM Dexmedetomidine 150mcg
- Total sedation time: 120 min
- Discharge without complication

CASE 2

- 10/M
- 124.3cm/23.5kg
- Whole body MRI for Neurofibromatosis
- s/p C2-6 Laminoplastic laminotomy
- Severe Craniovertebral and C4-5 kyphoscoliosis
- No snoring or history of sleep apnea
- 126/69 PR 48 SpO_2 96% on Room air
- Airway exam : Severely limited neck extension

- IV Dexmedetomidine 1.5mcg/kg loading for 10min
- IV Dexmedetomidine 1.5mcg/kg/hr continuous infusion
- O_2 4L/min by Oxymask
- BP, SpO_2, $ETCO_2$ monitoring
- Total scan time: 70 min
- PACU time: 20 min
- Discharge without complication

CASE 3

- 5/F
- 94cm/12.7kg
- Heart CT for FSV
- FSV s/p BCS
- OSAS considering CPAP
- Hx. of intubation failure d/t Trismus
- 99/63-84-28-82% on Room air
- Airway exam : mouth opening 1FB, retrognathia

- IV Propofol 12mg ivs
- Oral airway insertion → I-gel # 1.5 change
- BP, SpO_2, $ETCO_2$ monitoring
- Total scan time: 15min
- PACU time: 35 min (I-gel removal after 7 min of arrival)
- Discharge without complication

CASE 4

- 5/F
- 112.7cm/15.6kg
- Face MRI for Lymphangioma
- Being able to sleep only in a right-side lying position
- Hx. of failure of sedation d/t airway obstruction
- 122/82-101-24-98% on Room air
- Airway exam : Stridor (+), Mallampati's class IV

- IV Propofol 30mg + succinylcholine 30mg
- Intubation using Video laryngoscope with e-tube #4.5
- Maintenance : Sevoflurane + IV rocuronium 20mg
- BP, SpO_2, $ETCO_2$ monitoring
- Total scan time: 55 min
- Extubation at PICU (after 1hr of arrival)
- Discharge without complication

CASE 5

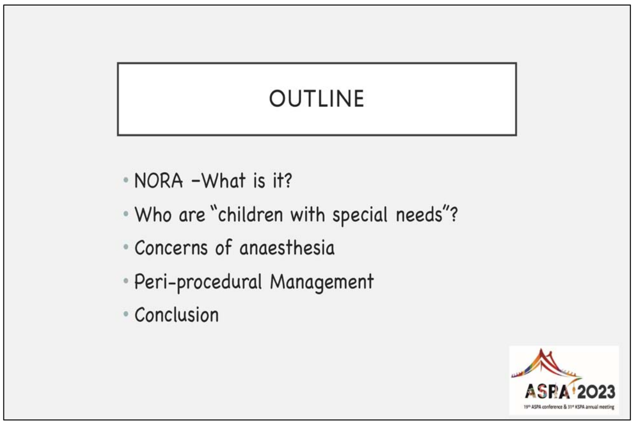
- 9/M
- 130cm/25kg
- Brain MRI for Brain abscess
- DORV, PA s/p BCS, s/p One and a half repair
- Lt. main bronchus stenosis
- SVC syndrome d/t BCS stenosis
- HF induced Protein losing enteropathy
- Home vent: Nasal iVAPS mode (EPAP 6cmH2O, O2 1L/min)
- 89/56-101-27-85%

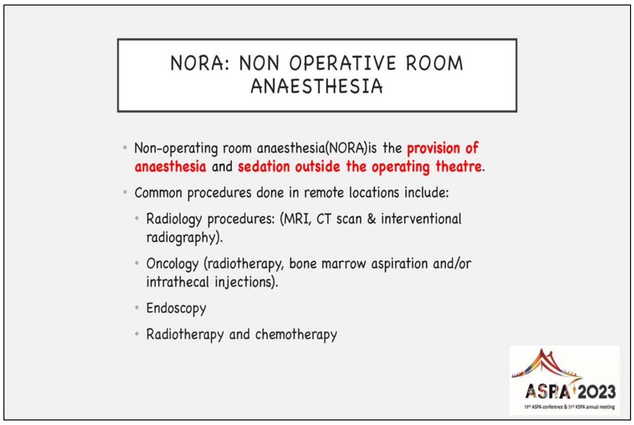
- Hx. of Apnea after sedation during Heart CT
- Performing Brain MRI without sedation
- Using Inroom Viewing Device
- Minimizing scanning time: about 15min
- Using Home vent with extended, non-magnetic device

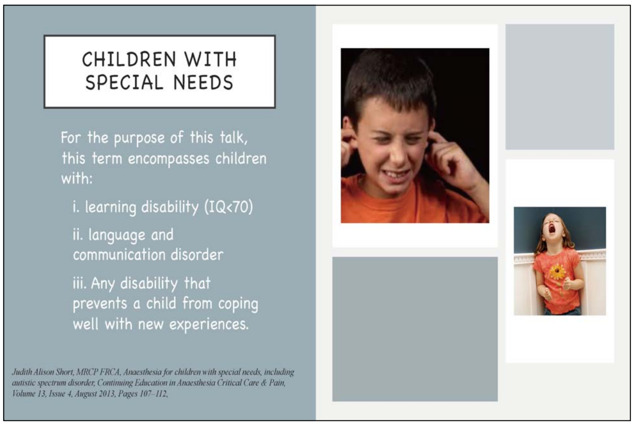
NORA for Children with Special Needs

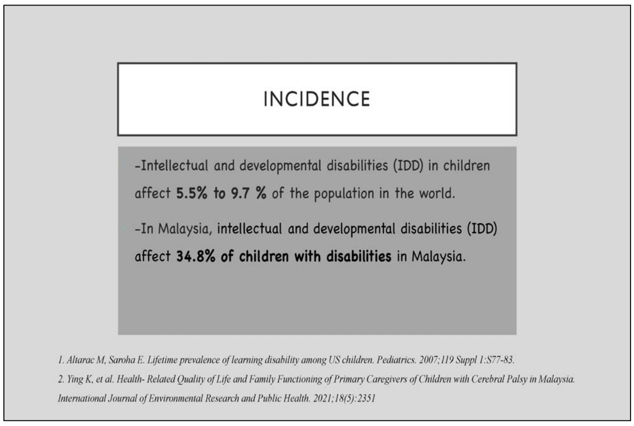
Ina Ismiarti Binti Shariffuddin

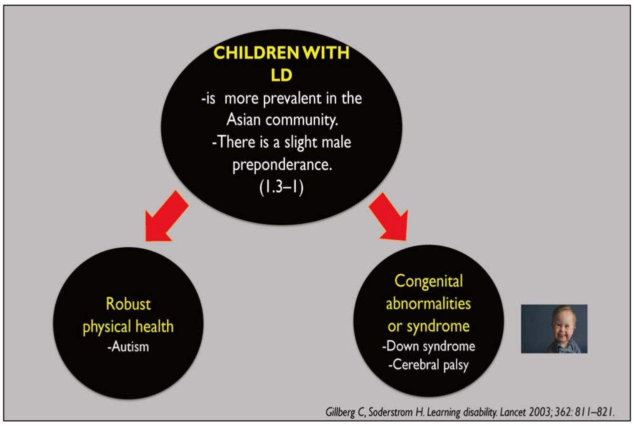
Department of Anaesthesiology, University Malaya, Malaysia











CHALENGES IN PATIENTS WITH SPECIAL NEEDS

- **Polypharmacy**
  - On stimulants and anti-psychotics.
    - Ritalin & Olanzepine
- **Psycho-social challenge:**
  - They may be very anxious
  - They may have **difficulty conforming** to the usual pattern of hospital care.

"**Hospital attendance is often stressful**".

ANAESTHESIA CONCERNS

Patient

- Frequently associated with multiple co-morbids that necessitates diagnostic imaging or therapeutic procedures
- Patients are often admitted as day case.

Table 4
Coexisting medical problems in learning disability

Condition	*Frequency*
Epilepsy	Up to 44% (42)
Psychiatric conditions	Up to 50% (31)
Eating disorders	– (31)
Self harming	– (31)
Attention deficit hyperactivity disorder	18% (32)
Schizophrenia	– (33)
Depression	– (34,35)
Sensory disorders	
Visual impairment	10x greater (36)
Hearing loss	40x greater (36)
Cerebral palsy	Common (5)
Miscellaneous	
Hypothyroidism	– (37)
Gastroesophageal reflux	49%(39)
Malignancies – stomach, gall-bladder, esophagus, thyroid, connective tissue	– (38)
Nonischemic cardiac disorders	– (40)
Poor dentition	– (41)

Difficult Airway

COURTMAN, S. P., & MUMBY, D. (2008). Children with learning disabilities. Pediatric Anesthesia, 18(3), 198–207.

WHO CAN BE TREATED IN NORA (DAY SURGERY SETTING)?

- The child should be well, with **only mild** and **well controlled comorbids***.
- Children with relatively complex needs, provided:
  - They are stable with **minimal cardiorespiratory problems***.
  - Do not have features of **difficult airway.**

Royal College of Anaesthetists. Guideline for the provision of paediatric anaesthesia services. 2019. https://www.rcoa.ac.uk/ document-store/guidelines-the-provision-of-paediatric-anaesthesia-services-2019

ANAESTHESIA CONCERNS

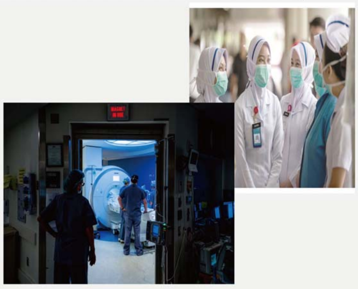
Environment

- Limited resuscitative and monitoring facilities.
- Cramped and congested work area.
- Low ambient temperature with risk of hypothermia in small babies.
- Inadequate space, monitoring facilities and trained staff at recovery bay.
- Unfamiliar working environment.

ANAESTHESIA CONCERNS

Personnel

- Lack of trained assistance to assist anaesthetist.
- The anaesthetist may not be familiar with the environment or the equipment provided.
- Lack of knowledge/expertise in handling patients with special needs.



PROBLEMS

Limitation of staff awareness

Inadequate training of staff about children with learning disability

Lack of suitable equipment & environment

Prolonged waiting times for operation date

Prolonged waiting on the day of operation

Lack of private space

Lack of non-invasive equipment

Teghazideh et al. Paeds Anaesthesia ,Vol 29, Issue 9, Sept 2019

PRE-ADMISSION MANAGEMENT:

- Adopt a flexible and holistic approach to care
- Coordinate interventions required by multiple specialities
- Consider family's & patient's needs
- Collect Information over the phone to avoid preoperative admission anxiety

PRE-OPERATIVE MANAGEMENT:

Communication between staff and family

-Ensure good communication

i. Clear plans & explanations

ii. Staff should show empathy

Individualized care within the hospital framework

-Health providers have to be flexible with standard protocols

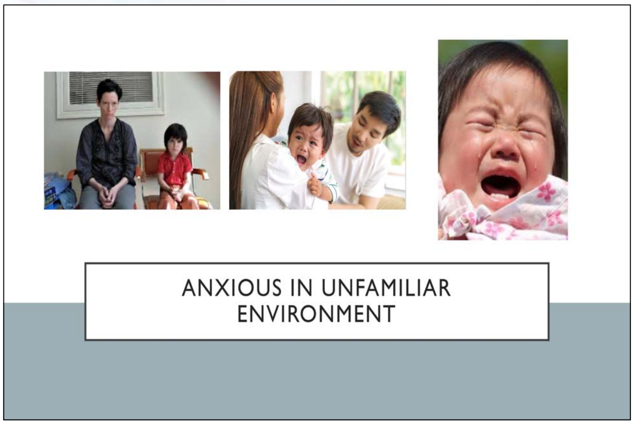
i. Avoiding unnecessary blood pressure measurements

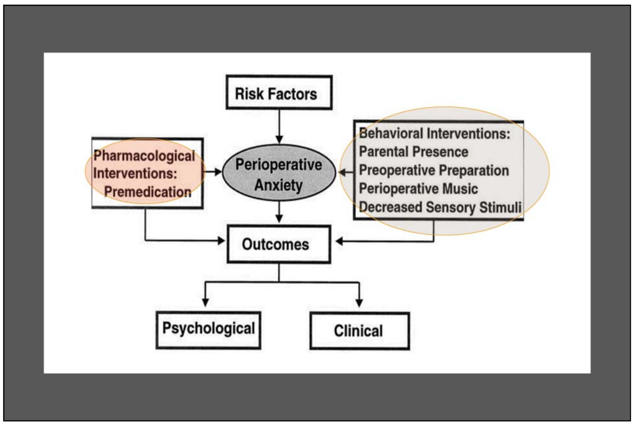
ii. Not changing into hospital gowns.

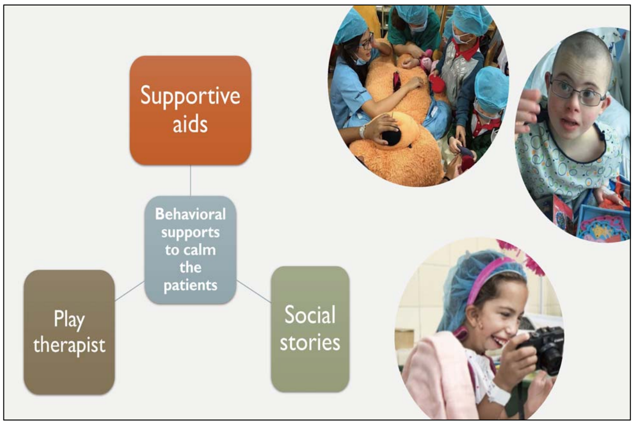

RESEARCH REPORT

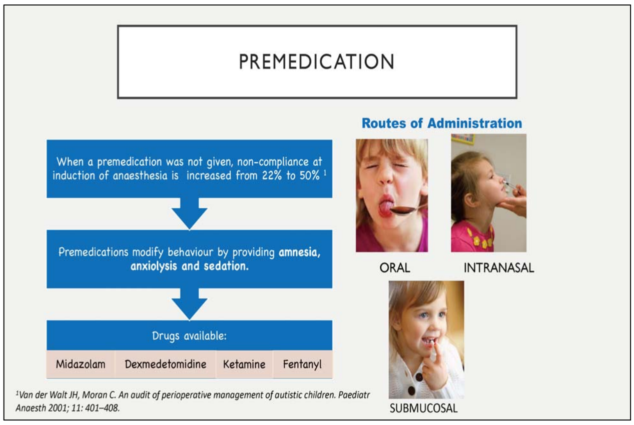
WILEY

The experiences of children with autism spectrum disorder, their caregivers and health care providers during day procedure: A mixed methods study









DOSE

DRUG	DOSE	Duration of action
MIDAZOLAM[1]	Oral 0.5-0.75 mg/kg Max at 15-20 mg IN: not recommended	Onset 10 mins Peak 30 mins
DEXMEDETOMIDINE[2]	IN 2mcg/kg	Onset: 20-30 min
KETAMINE[1]	Oral- 5-6mg/kg Need administration with antisialogogue Atropine 0.02 mg/kg	Onset 10 mins
FENTANYL[1]	Oral 5-15 mcg/kg PONV	Onset: 10 mins

Pasin L et al, Dexmedetomidine vs midazolam as preanesthetic medication in children: a meta-analysis of randomized controlled trials. *Paediatr Anaesth. 2015 May; 25(5):468-76.*
[1]*Cote CJ, Preoperative preparation and premedication BJA 1999, 83, 16-28*
[2] *Yuen et al*

Anaesthesia 2012, 67, 1210–1216 doi:10.1111/j.1365-2044.2012.07309.x

Original Article

A randomised comparison of two intranasal dexmedetomidine doses for premedication in children

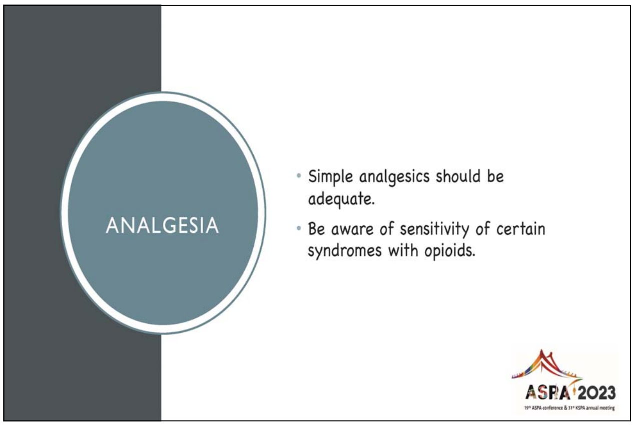
V. M. Yuen,[1] T. W. Hui,[1] M. G. Irwin,[2] T. J. Yao,[3] L Chan,[4] G. L. Wong,[5] M. Shahnaz Hasan[6] and I. I. Shariffuddin[6]

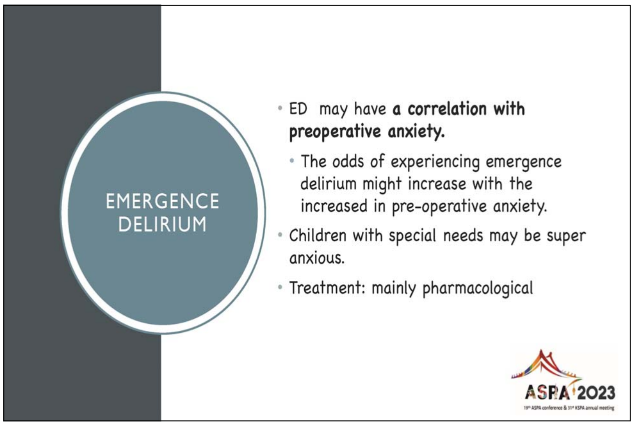
Conclusion:
-In children aged 1–4 years: IN DEX in doses of 1 and 2mcg/kg produced a similarly high rate of satisfactory sedation.
-In children aged 5–8 years, **IN DEX 2mcg/kg** was associated with a higher proportion of satisfactory sedation than 1mcg/kg without causing adverse haemodynamic effects

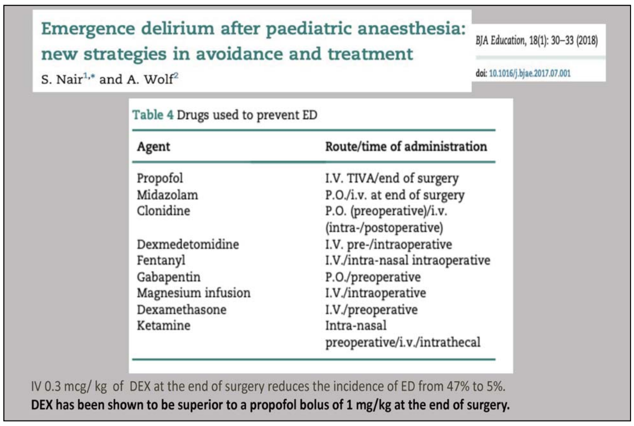
ANAESTHESIA

Anaesthesia drugs used will be determined by any co-existing morbidity.

Minimize postoperative nausea and vomiting:
- Administer antiemetic agent
- Adequate hydration with isotonic crystalloid fluid bolus.






Emergence delirium after paediatric anaesthesia: new strategies in avoidance and treatment

S. Nair[1,*] and A. Wolf[2]

BJA Education, 18(1): 30–33 (2018)

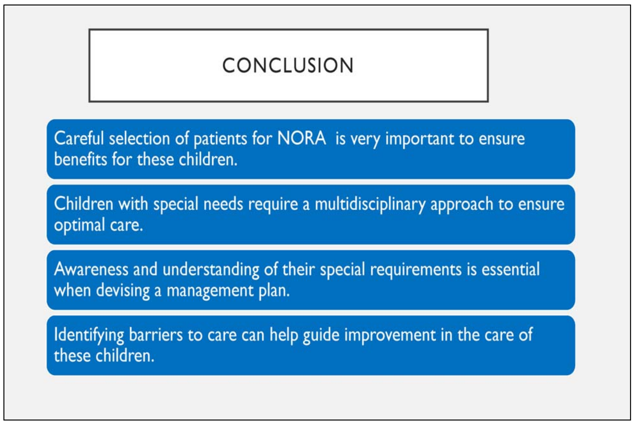
doi: 10.1016/j.bjae.2017.07.001

Table 4 Drugs used to prevent ED

Agent	Route/time of administration
Propofol	I.V. TIVA/end of surgery
Midazolam	P.O./i.v. at end of surgery
Clonidine	P.O. (preoperative)/i.v. (intra-/postoperative)
Dexmedetomidine	I.V. pre-/intraoperative
Fentanyl	I.V./intra-nasal intraoperative
Gabapentin	P.O./preoperative
Magnesium infusion	I.V./intraoperative
Dexamethasone	I.V./preoperative
Ketamine	Intra-nasal preoperative/i.v./intrathecal

IV 0.3 mcg/ kg of DEX at the end of surgery reduces the incidence of ED from 47% to 5%.

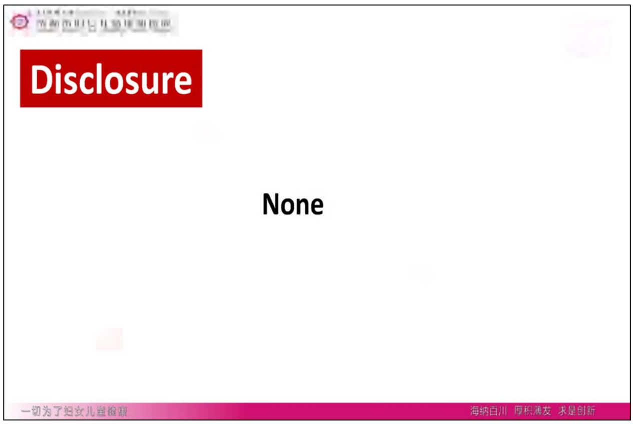
DEX has been shown to be superior to a propofol bolus of 1 mg/kg at the end of surgery.

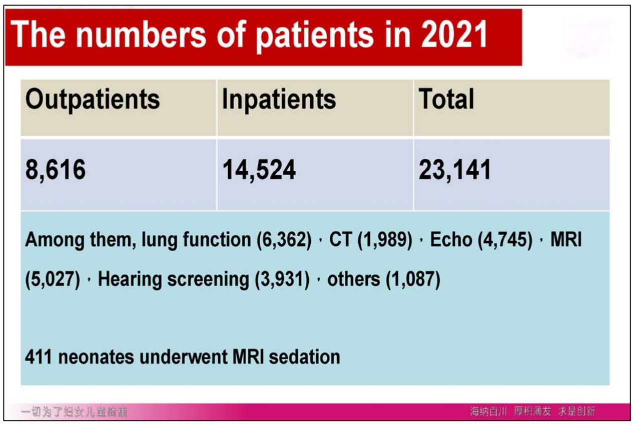


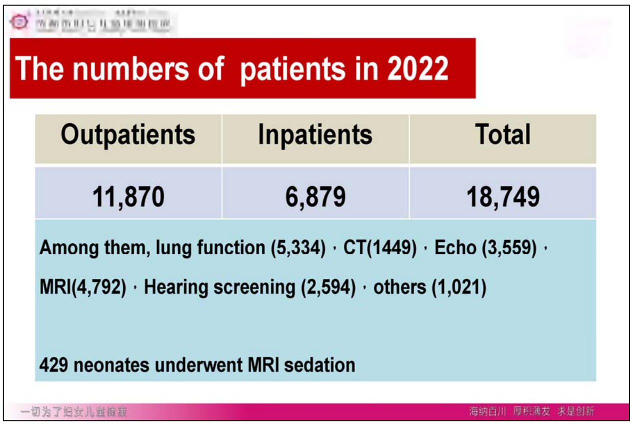
Neonatal Sedation for MRI

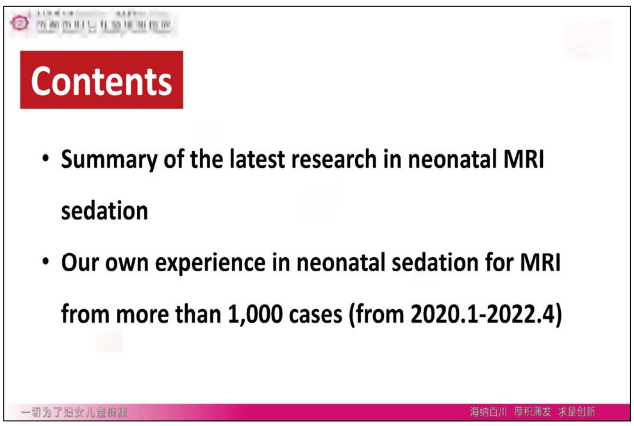
Yu Cui

Chengdu Women and Children's Central Hospital, China









A survey from Italian Society of Pediatric and Neonatal Anesthesia (SARNePI)

- 106 institutions met minimal criteria for MRI procedures on pediatric patients
- To NICU neonates, 53 centers performed less than 3 MRI procedures per week, while 12 centers performed more than 3 procedures MRI per week.

Table 5 First choice Sedation technique in NICUcenters

Sedation in NICU centers n. 65			
Drug Sedation	Yes n. 43 (66%)		None n. 22 (34%)
	Sevorane n. 21 (49%)	Midazolam n. 9 (21%)	
	Thiopental n. 4 (9%)	Multidrugs[a] n. 9 (21%)	
Pharmacological premedication	Yes n. 8 (18%)		None n. 57 (82%)
	Benzodiazepine n. 8 (100%)		
Airway devices	Endotracheal Tube n. 4 (9%)	Laryngeal Mask n. 3 (7%)	External device n. 36 (84%)

[a] Center with no preferent sedation or with use of multidrugs association (even both volatile and intravenous agents)

Sbaraglia F, Spinazzola G, Adduci A, et al. Children and neonates anesthesia in magnetic resonance environment in Italy: an active call survey. BMC Anesthesiol. 2022;22(1):279. doi:10.1186/s12871-022-01821-3

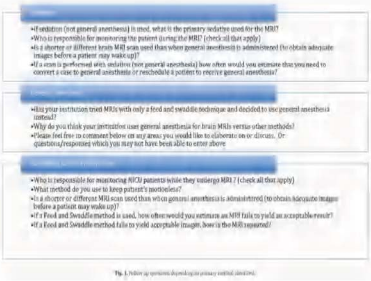
A survey from North American physician members of the Society

- The final results represented 59 institutions from 26 U.S. states, the District of Columbia and three Canadian provinces.
- In neonates undergoing MRI, 46% of respondents reported attempting feed and bundle in all patients , with most (35%) using a single swaddling attempt before sedation.
- Sedation was most often used for neonatal interventional procedures (93%).
- More than half of respondents (63%) reported an average success rate of greater than 50% when using neonatal sedation for MRI.

Hwang M, Barton K, Kim JS, et al. Utilization of neonatal sedation and anesthesia: an SPR survey. Pediatr Radiol. 2022;52(13):2630-2635. doi:10.1007/s00247-022-05423-6

Can we reduce anesthesia exposure? Neonatal brain MRI: Swaddling vs. sedation, a national survey

- This is a national survey of NICUs in the United States with a Neonatology Fellowship Program.
- The questions were as follows, including sedation, GA, and swaddling without medication.



Heller BJ, et al. Can we reduce anesthesia exposure? Neonatal brain MRI: Swaddling vs. sedation, a national survey. J Clin Anesth. 2017;38:119-122. doi:10.1016/j.jclinane.2017.01.034

- In the feed and swaddle group, 81% reported that a failure to obtain useful images occurred < 25%; 11% reported that it occurred 25–75%; and 5% reported that it occurred>75%.
- In the drug sedation and GA group, 100% reported failure to obtain useful images occurred rarely.

Drug sedation

一切为了妇女儿童健康 海纳百川 厚积薄发 求是创新

Midazolam

Sedative effect of intranasal midazolam in neonates undergoing MRI

- A total of 70 neonates were randomized into an observation group and a control group, with 35 cases in each group.
- The observation group received intranasal drops of midazolam (0.3 mg/kg), and the control group received intramuscular injection of phenobarbital sodium (10 mg/kg).
- Ramsay sedation scores are as follows.

Group	10min	20min	30min	40min	50min	60min	70min
Phenobarbital	2.8±0.6	3.0±0.6	3.4±0.6	3.4±0.8	3.4±0.8	3.3±0.9	3.2±1.0
Midazolam	3.5±0.8	3.9±0.5	3.7±0.7	3.7±0.8	3.6±0.9	3.5±1.0	3.3±1.1
P values	<0.001	<0.001	0.020	0.206	0.419	0.398	0.735

Wang FH, et al. Sedative effect of intranasal midazolam in neonates undergoing magnetic resonance imaging: a prospective single-blind randomized controlled study. Zhongguo Dang Dai Er Ke Za Zhi. 2020;22(5):441-445.

Dexmedetomidine

Intranasal administration is an alternative route explored.

53 neonates (at ≤32 weeks of gestation or with a birth weight of ≤1500 g)

The historical midazolam group received sedation with boluses of intranasal (0.1-0.2 mg/kg) or intravenous (0.05-0.1 mg/kg) midazolam.

The dexmedetomidine sedation group received a single dose of intranasal dexmedetomidine 3ug/kg, with intranasal or intravenous midazolam as rescue therapy.

The report shows that dexmedetomidine spares the use of midazolam in preterm neonates undergoing MRI at term equivalent age.

Bua J, et al. Intranasal dexmedetomidine, as midazolam-sparing drug, for MRI in preterm neonates. Paediatr Anaesth. 2018;28(8):747-748.

Sevoflurane

Advantages	Disadvantages
A sevoflurane concentration of approximately 1.5–2% can provide a success rate of 97.9%.	0.4% severe airway-related adverse events, and 0.2% had severe respiratory apnea.

De Sanctis Briggs V. Magnetic resonance imaging under sedation in newborns and infants: a study of 640 cases using sevoflurane. Paediatr Anaesth. 2005;15(1):9-15.
Lei H, et al. Serious airway-related adverse events with sevoflurane anesthesia via facemask for magnetic resonance imaging in 7129 pediatric patients: A retrospective study. Paediatr Anaesth. 2019;29(6):635-639

A solution based on melatonin, tryptophan, and vitamin B6 can be used for newborns during brain MRI

Thirty minutes before MRI assessment, they administered Melamil Tripto© oral solution, Humana Italia S.p.A, Milan, Italy

Regardless of body weight.

1 mg of melatonin	20mg of tryptophan	1.4 mg of vitamin B6
0.5ml		

Table 3 Effect of melatonin administration during MRI performing and patient evaulation after MRI

	2 mg (32)	3 mg (72)	4 mg [5]	p-value
Quality of MRI				
Positive (patient, %)	26 (81,2%)	67 (93%)	5 (100%)	
Diffucult (patient, %)	6 (17,8%)	2 (2,7%)	0 (0%)	
Negative (patient, %)	0 (0%)	3 (4,3%)	0 (0%)	
				0,04
Waking state after MRI				
Awake, tends to fall asleep	10 (31,2%)	16 (22,2%)	0 (0%)	
Awake if stimulated	3 (9,3%)	7 (9,8%)	0 (0%)	
Awake	19 (59,5%)	49 (68%)	5 (100%)	
				0,6

Picone S, et al. A solution based on melatonin, tryptophan, and vitamin B6 (Melamil Tripto©) for sedation in newborns during brain MRI. Ital J Pediatr. 2019;45(1):122.

海纳百川 厚积薄发 求是创新

Non-drug sedation

海纳百川 厚积薄发 求是创新

Cardiovascular MRI using a feed-and-sleep technique in neonates and infants

- Case-series study
- The infant has been fasted for a period of 4 h prior to the scan.
- Fed just prior to the procedure.
- The infant is swaddled with one or two sheets before being placed within a vacuum immobilizer.

Conculsion

- Using this technique, infants younger than 6 months can complete a cardiovascular MRI without the need for sedation or general anesthesia

Fig. 1 Photo of an infant swaddled in a MedVac bag prior to being placed in the scanner

Windram J, et al. Cardiovascular MRI without sedation or general anesthesia using a feed-and-sleep technique in neonates and infants. Pediatr Radiol. 2012;42(2):183-187;

Application of vacuum stretcher combined with feeding in cranial magnetic resonance imaging examination for neonates

- Neonates with a gestational age of >34 weeks underwent MRI
- The neonates were randomly divided into a vacuum stretcher combined with feeding group and a conventional sedation group(10% chloral hydrate 0.5mg/kg)

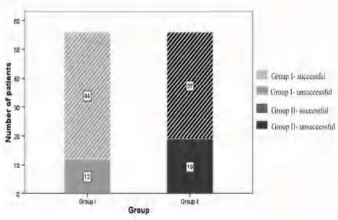
	10% chloral hydrate (n=40)	Vacuum stretcher combined with feeding (n=40)	P value
Successed	30	37	0.034
Interrupt during procedures	3	8	0.105
MRI duration	6.0(6.0, 25.8)	6.0(6.0, 6.8)	0.493

Shen XX, et al. Zhongguo Dang Dai Er Ke Za Zhi. 2020;22(5):435-440.

Oral 30% glucose provides sufficient sedation in newborns during MRI

- Group 1: 0.5-3 ml 30% glucose orally
- Group 2: 0.1 mg/kg midazolam

Fig. 1 Comparing the efficiency of the techniques according to the number of patients for groups



Eker HE, et al. Oral 30% glucose provides sufficient sedation in newborns during MRI. J Anesth. 2017;31(2):206-211.

Our own experience

海纳百川 厚积薄发 求是创新

Choice 1: Non-drug techniques

About 20% neonates could be successfully sedated by non-drug techniques during MRI.

Sleep deprivation

海纳百川 厚积薄发 求是创新

Choice 2: Chloral Hydrate

1148 neonates were retrospectively analyzed

2019.12 to 2022.12

Characteristics	Values
Males[n(%)]	697 (60.7)
Birth days，days	11.0 (6.0, 16.0)
Weight，kg	3.3(3.0, 3.7)
Source[n(%)]	
Outpatients	211 (18.4)
Inpatients	937 (81.6)
Sedation history[n(%)]	104 (9.0)
Procedurs[n(%)]	
MRI	998 (86.9)
MRI and Auditory brainstem response (ABR)	148 (12.9)
MRI and Echo	1 (0.1)
MRI and Hearing screen	1 (0.1)
Rount[n(%)]	
Oral	1035 (90.2)
Intranasal	64 (5.6)
Gastric tube	31 (2.7)
Rectal	18 (1.6)

海纳百川 厚积薄发 求是创新

	Numbers (n=1148)
Initial dose of chloral hydrate, mg/kg	49.4 (48.1, 50.0)
Initial success rate, n(%)	91.0%
Complictions, n(%)	
Vomiting	65(5.6)
Delayed awakening(>2h)	23(2.0)
Respiratory depression	8(0.7)
Choking	3(0.3)
Severe adverse events	0 (0.0)

Choice 3: Midazolam

More than 100 neonates were successfully sedated by oral midazolam during MRI.

0.5mg/kg midazolam syrup provides a sedation success rate of 100% for neonates.

ASPA 2023

Session 4.

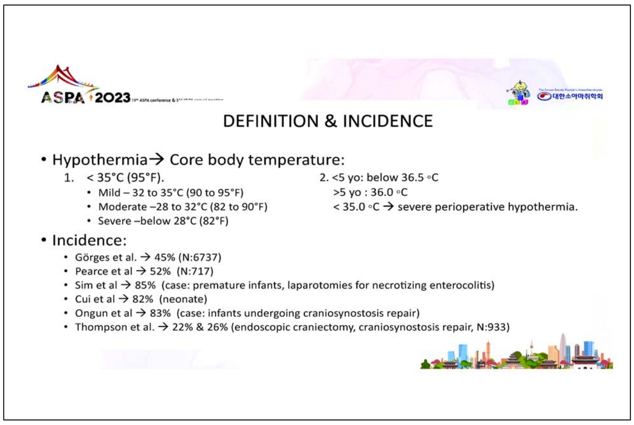
Perioperative Concerns in Pediatric Anesthesia

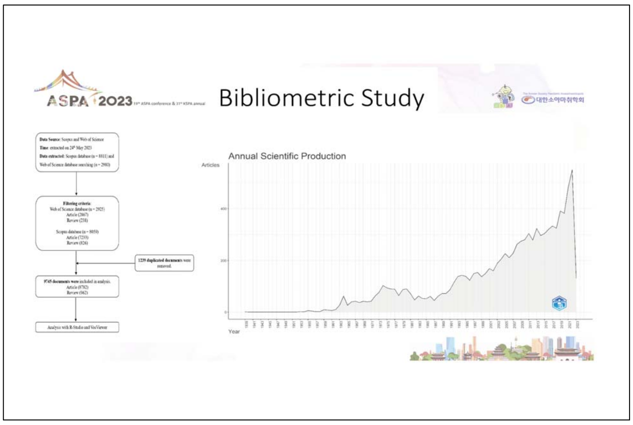
Chair(s): Tae-Hun Ahn (Korea)
Woo Suk Chung (Korea)

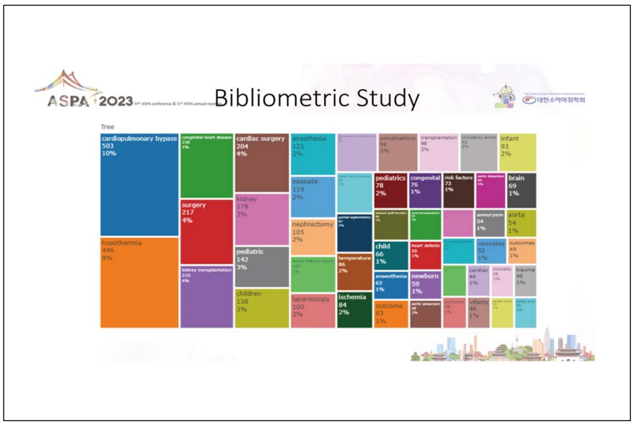
Perioperative Hypothermia in Children: Risk Factor and Preventive Strategy

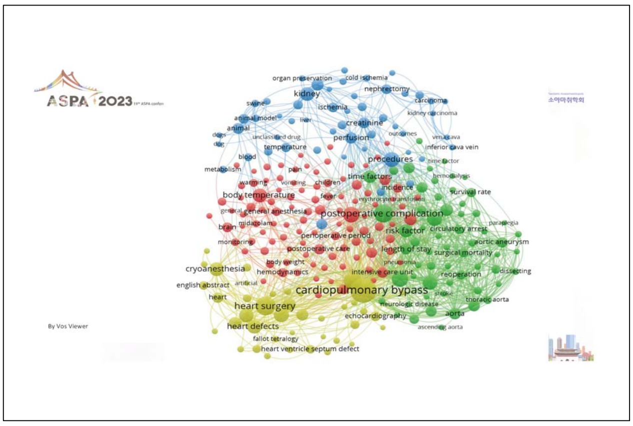
Djayanti Sari

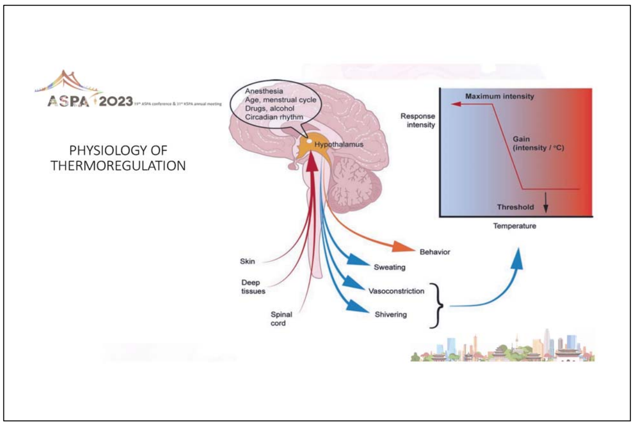
Universitas Gadjah Mada, Indonesia

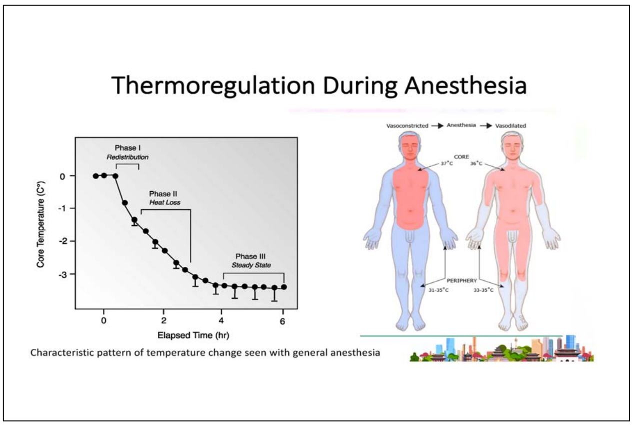




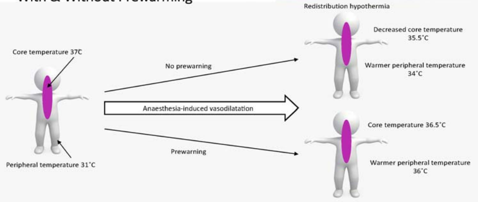








Effect Of Anesthesia Induced Vasodilation on Core & Peripheral Temperature With & Without Prewarming



Pediatric proneness (especially neonate) to perioperative hypothermia:

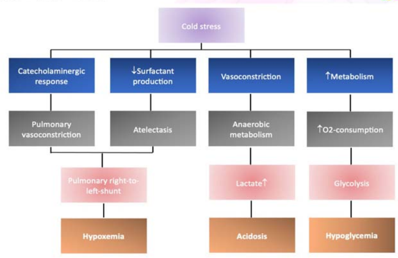
1. Greater heat loss:
   - Regulatory capacity is less effective than in adults
   - Reduced weight-to-surface-area (WSA) ratio
   - Increased heat loss from the head
   - Limited stores of subcutaneous fat for thermal insulation
   - Neonates are have no behavioural regulation.
2. Increased basal metabolic rate (compared with adults).
3. Effector mechanisms of skeletal muscle stimulation are minimal → heat generation depend on non-shivering thermogenesis
4. ELBW neonates have poor vasomotor control at birth (unable to exhibit peripheral vasoconstriction to preserve heat)
5. (+) general anaesthesia → lowers the threshold for vasoconstriction and other compensatory mechanisms including NS thermogenesis.
6. During surgery: Cold OR, administration of cold fluids, the application of dry anaesthetic gases, and wound exposure.

ADEVRESE EVENT

- Discomfort to morbidity & mortality
- Concern in:
  - pharmacokinetics and pharmacodynamics (essentially muscle relaxants)
  - platelet function, coagulation, and blood loss,
  - cardiocirculatory & respiratory complications,
  - wound healing and surgical site infections (SSI), and
  - thermal discomfort

→ possible consequences: apnoea and need for mechanical ventilation, arrhythmias, increased risk of infections, prolonged length of hospital stay, poor neurologic outcome, death.

PATOPHYSIOLOGY PATHWAY



SOLUTION ?

1. RISK FACTOR IDENTIFICATION
2. MONITORING
3. MANAGEMENT & PREVENTION

RISK FACTOR

1. Low body weight
2. Prematurity
3. major intestinal surgery, invasive procedures
4. OR temperature less than 23 ◦C
5. Neonates receiving interventional cardiac procedures
6. type & duration of surgery (e.g., major orthopedic surgery)
7. Low baseline temperature
8. High blood loss & transfusion requirement
9. Inadequate core temperature monitoring.

MONITORING

Pre-OP	Intra-OP (General Anaesthesia)	Post-OP
• Oral, axillary (rectal) • (Tympanic)	Continuous methods: • Oesophageal • Nasopharyngeal • Non-invasive methods based on ZHF technology • Bladder, rectal	Serial measurements: • Oral, axillary (rectal) • (Tympanic) • Hypothermic patients: Continuous methods, e.g., non-invasive methods based om ZHF technology • Intubated patients: see Intra-OP

Evidence-based Studies on Methods for Preventing Hypothermia

Author(s)	Study Type	Number of Cases	Method	Result
Lars Witt et al. (2013)	Prospective multicenter observational study	190	Intraoperative Hot Air Blown System	Decrease in unwanted hypothermia
Wong et al. (2007)	RCC	103	Preoperative period	Decrease unwanted hypothermia carbon polymer bed reduced blood loss
Leeth et al. (2010)	RCC	105	Postoperative period; hot air blowing system	Body temperature is the same amount of increase in thermal comfort, cost reduction
De Witte et al. (2010)	RCC	26	Preoperative period; carbonfiber blanket body temperature increase	Postoperative period; hot air blown
Hooven (2011)	Cohort	149	Postoperative period; hot air blowing system	An increase in body temperature

PREVENTION & MANAGEMENT

1. Warming Therapy during Transport
   - Dressed for as long as possible & covered with blankets, (optional) a warming pad
   - Ideally: prewarmed bed, provided with radiant heater or warming mattress.
   - Especially preterm infants & neonates → warmed incubator.
   - Keep incubator plugged in during the surgical procedure
2. Warming before Induction of Anesthesia
   - OR 'warm' enough → In general, a room temperature:
     - 32 ◦C for neonates
     - 24 ◦C and 30 ◦C for infants.
   - start active warming therapy before induction of anesthesia.

3. Warming Therapy during Anesthesia
   - active warming therapy must be continued
   - irrigation solutions should be warmed to body temperature.
4. Infusion Warming
   - warm fluids and blood products with a blood and fluid warmer
   - Concern: length of the infusion tubing
5. Warming Therapy after Anesthesia
   - extubation should not be performed when children are hypothermic.
   - If hypothermic → should be rewarmed during anesthesia & then extubated.
   - Postoperative phase: core temperature should be measured regularly

CONCLUSION

- Pediatric today still often become hypothermic, due to their vulnerable physiology & insufficient perioperative hypothermia prevention/management.
- A good perioperative prevention strategy must be planned.
- With risk identification, good monitoring and prevention, It is possible to avoid perioperative hypothermia .

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Emergence Agitation & Long Term Behavioral Consequences

Agnes Ng

KK Women's and Children's Hospital, Singapore

AGITATION (symptom)

DSM-5 "excessive motor activity associated with a feeling of inner tension.

Unpleasant state of extreme arousal (stirred up or excited), increase tension and irritability

Pain, Hunger, Physiological compromise,

or

Fear or Anxiety, absence of a primary caregiver or unfamiliar surroundings

DSM-5

Diagnostic and Statistical Manual of the American Psychiatric Association (DSM-5)

A. **Disturbance in *attention*** (i.e., reduced ability to direct, focus, sustain, and shift attention) and **awareness** (reduced *orientation to the environment*).

B. The disturbance develops over a short period of time (usually hours to a few days), ***represents an acute change from baseline attention and awareness,*** and tends to fluctuate in severity during the course of a day.

C. An additional **disturbance in cognition** (e.g. memory deficit, disorientation, language, visuospatial ability, or perception).

D. *The disturbances in Criteria A and C* are not better explained by a pre-existing, established or evolving neurocognitive disorder and *do not occur in the context of a severely reduced level of arousal such as coma.*

E. There is evidence from the history, physical examination or laboratory findings that the disturbance is *a **direct physiological consequence*** of another medical condition, *substance intoxication or withdrawal (i.e. due to a drug of abuse or **to a medication**), or exposure to a toxin, or is due to multiple etiologies.*

Emergence Delirium

Mental disturbance during recovery

- Dissociated state of unconsciousness
- Altered cognitive perception
- Agitated behaviour

Incidence and Etiology of Postanesthetic Excitement: Clinical Survey
James E. Eckenhoff et al Anesthesiology 1961

Excitement: Restlessness, disorientation, crying, moaning or irrational talking,

Delirium: Wild thrashing, shouting and screaming

Incidence 5.3% in 14,436 patients; adults and children (12-13%),

Contributing factors:

- Age (3-9 yr)
- ASA 1
- Premed: barbiturate and scopolamine premed
- Cyclopropane or ether anesthesia
- Operative procedures associated with pain or emotional stress

Emergence Delirium

- Has been described with every anaesthetic agent (especially ether and cyclopropane)
- Decreased markedly with halothane
- Incidence EXPLODED with sevoflurane (& desflurane)

What parents

Say: "whatever I did, didn't help….please take him away and give me my child back"

Describe: "the devil having jumped into him – he was pitch black"

Experience: "fear and insecurity, feelings of powerlessness and guilt

Wells & Rasch Anesth Analg 1999;88:1308-10
Ringblom Scand J Caring Sci 2022;36:1104-1112

Emergence Delirium

Generally self limiting

- May result in physical harm to patient & caregiver
- Dislodgement of drains & IV sites
- Pain and bleeding of surgical sites
- Distressing to all

Why incidence varies?

PAED Scale

1 The child makes eye contact with the caretaker
2.The child's action are purposeful
3.The child is aware of his surroundings
(implies consciousness & cognition)

0= extremely
1= very much
2= quite a bit
3= just a little
4= not at all

4.*The child is restless*
5.*The child is in inconsolable*
(reflects psychomotor behaviour & emotion e.g. pain or apprehension)

0= not at all
1= just a little
2= quite a lot
3 = very much
4 = extremely

Anesthesiology 2004; 100:1138–45 © 2004 American Society of Anesthesiologists, Inc. Lippincott Williams & Wilkins, Inc.

Development and Psychometric Evaluation of the Pediatric Anesthesia Emergence Delirium Scale

Nancy Sikich, M.Sc., R.N., Jerrold Lerman, B.A.Sc., M.D., F.R.C.P.C., F.A.N.Z.C.A.†*

Cravero Emergence Agitation scale

Level	Description
1	Obtunded with no response to stimulation
2	Asleep but responsive to movement or stimulation
3	Awake and responsive
4	*Crying (>3 minutes)*
5	*Thrashing behaviour that requires restraint*

Watcha Behavior scale for emergence delirium

Level	Description
1	Calm
2	Crying, but can be consoled
3	*Crying, cannot be consoled*
4	*Agitated and thrashing around*

- All three scales correlated reasonably well with each other
- PAED score >12 appears to provide greater sensitivity and specificity than a PAED score ‡10.
- Watcha scale appears to be a practical tool to use and assess ED in the PACU

Hypoactive Delirium

ICU-delirium

Quiet, confused, disorientated, no eye contact
Minimal movements when awake, non-communicative and do not respond to social interaction

RESEARCH REPORT

Pediatric Anesthesia WILEY

An observational study of hypoactive delirium in the post-anesthesia recovery unit of a pediatric hospital

Paul F. Lee-Archer[1,2,3] | Britta S. von Ungern-Sternberg[4,5,6] | Michael C. Reade[2] | K.C. Law[1] | Deborah Long[3,7]

Pediatric Anesthesia. 2021;31:429–435.

The Cornell Assessment of Pediatric Delirium (CAP-D) was developed as an adaptation and extension of the PAED scale and is a rapid screening tool for pediatric delirium in the hospital setting (Figure 1). The additional items that are included to assess hypoactive delirium are as follows:

1. Does the child communicate needs and wants?
2. Is the child underactive—very little movement while awake?
3. Does it take the child a long time to respond to interactions?

Clinical Implications

What is already known about this topic

- Emergence delirium is a common problem in children recovering from general anesthesia.
- Hypoactive delirium has been well-described in children in the intensive care unit but has not been widely studied in the recovery setting.

What this study adds

- Nearly a quarter of all cases of emergence delirium in a single pediatric hospital were found to be hypoactive in nature.
- The Cornell Assessment of Pediatric Delirium is a rapid, easy-to-use tool that is an extension of the Pediatric Assessment of Pediatric Delirium scale. It can detect hyperactive and hypoactive delirium and may be an appropriate measure for use in recovery units.

PAED detected 57 cases
CAP-D 74 cases 1.7%
57 cases using PAED
17 (23%) represent cases of hypoactive ED

Significance yet to be explored

Emergence Delirium lead to long term Psychological Harm?

- Higher risk
- Less neurocognitive reserves

Long term effects of ED

Maladaptive behaviour

e.g. general anxiety, night-time crying, enuresis, sleeping and eating problems

- 10 point increase of state anxiety scores increases odds by 10% of having marked ED and 12.5% one or more new onset post-op maladaptive behaviour changes
- Parents at high risk of preoperative anxiety, ED and maladaptive behaviour are more anxious in the holding area
- Children with marked ED OR 1.43 having one or more new onset post-op maladaptive behaviour changes

Kain et al Anesth Analg 2004;99:1648-54

Received: 30 December 2020 | Revised: 10 May 2021 | Accepted: 10 June 2021
DOI: 10.1111/pan.14259

RESEARCH REPORT

Pediatric Anesthesia WILEY

Volume 31, Issue 10
Pages: i, 1019-1133
October 2021

Behavioral changes after hospital discharge in preschool children experiencing emergence delirium after general anesthesia: A prospective observational study

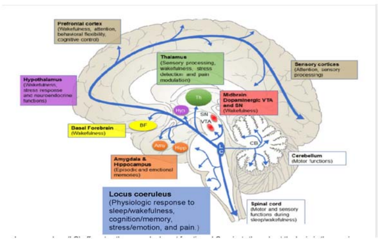
Jonghae Kim[1] | Sung Hye Byun[2] | Jun Won Kim[3] | Ji-Yoon Kim[4] | Yun Jin Kim[5] | Nayeon Choi[5] | Bong Soo Lee[4] | Seungcheol Yu[4] | Eugene Kim[6]

Results: Children with emergence delirium ($n = 58$) had higher postoperative behavior checklist scores than children without emergence delirium ($n = 42$) [mean (SD), 22.8 (17.5) vs. 14.0 (12.1); mean difference (95% CI), 8.8 (1.5–16.2)]. Increases in preoperative anxiety level [regression coefficient (b) (95% CI) =0.241 (0.126–0.356)] and peak delirium-specific score [b = 0.789 (0.137–1.442)] were associated with an increase in behavior checklist score 1 week after surgery, while pain-related score, type of surgery, premedication, and age were not.
Conclusion: Children with emergence delirium developed more severe behavior changes 1 week after surgery than those without emergence delirium. High preoperative anxiety level and emergence delirium scores were associated with posthospital behavioral changes.

But results
Incidence ED 58%
ED needed more analgesics 89.7% vs. 47.6%

Emergence Delirium
- possible etiological factors

Emergence from general anesthesia is not a PASSIVE reversal process
Now reconsidered, distinct and as an active and controllable process.



Escape From Oblivion: Neural Mechanisms of Emergence From General Anesthesia. I
Max B. Kelz
Anesth Analg. 2019 April

YOUNG CHILD
CHILD'S TEMPERAMENT

EMERGENCE DELIRIUM

ENT/EYE surgery
Duration
PARENTAL ANXIETY
VOLATILE ANAESTHETICS
Rapid emergence
Mechanism

Frontal electroencephalogram activity during emergence from general anaesthesia in children with and without emergence delirium

Jonghae Kim[1], Hyung-Chul Lee[2], Sung-Hye Byun[1], Hyunyoung Lim[3], Minkyu Lee[3], Yoojin Choung[3] and Eugene Kim[3,*]

British Journal of Anaesthesia, 126 (1): 293–303 (2021)

Editor's key points

- Electrical oscillations between the cortex and thalamus, and between cortical regions and hemispheres, appear to provide important information on different states of consciousness, including general anaesthesia and delirium.
- Emergence delirium is a challenge in paediatric anaesthesia, and it occurs commonly in children during emergence from general anaesthesia.
- This research shows that certain EEG patterns before emergence from anaesthesia are strongly associated with emergence delirium in children, including high relative delta power and an increased ratio of low-frequency (i.e. delta and theta) to high-frequency (i.e. alpha and beta) oscillations.
- Transitioning rapidly from deep anaesthesia to wakefulness, reflected by the absence of an EEG pattern resembling non-rapid eye movement stage 2 sleep, might predispose children to emergence delirium.

Alterations in the Functional Connectivity of Frontal Lobe Networks Preceding Emergence Delirium in Children

Jessica C. Martin, B.Sc., B.Eng., David T. J. Liley, M.B., Ch.B., Ph.D., A. Simon Harvey, M.D., F.R.A.C.P., Levin Kuhlmann, B.Sc., Ph.D., Jamie W. Sleigh, M.B., Ch.B., F.F.A.R.C.S., F.A.N.Z.C.A., F.J.F.I.C.M., M.D., Andrew J. Davidson, M.B.B.S., M.D., F.A.N.Z.C.A., Grad.Dip.Epi.Bio.Stat.

Anesthesiology, V 121 • No 4

What This Article Tells Us That Is New

- In children without emergence delirium, an electroencephalogram pattern of sleep or drowsy states was observed before peaceful awakening.
- In children with emergence delirium, arousal with clinical delirium occurred before observation of electroencephalogram patterns of sleep.
- Frontal regional functional connectivity was significantly elevated in emergence delirium compared with that of matched controls shortly after discontinuation of anesthesia.

Absence of sleep EEG pattern associated with ED

Management of Emergence Delirium

Determine incidence *in your own institution*
Ensure departmental Analgesic and PONV strategy

Evaluation of emergence delirium in Asian children using the Pediatric Anesthesia Emergence Delirium Scale
KKH

The incidence of ED is approximately **10%** in our population of healthy, unpremedicated Asian children undergoing day surgery.

Young age, poor compliance at induction, lack of intraoperative fentanyl use and rapid time to awakening were predictive risk factors for ED in our population.

A PAED Score of ≥10 correlated to clinically significant ED

Choon L. Bong Pediatric Anesthesia 2009 19: 593–600

Anaesthesia 2015, 70, 393–399 doi:10.1111/anae.12867

Original Article

Overall incidence ED 39.2%

A comparison of single-dose dexmedetomidine or propofol on the incidence of emergence delirium in children undergoing general anaesthesia for magnetic resonance imaging*

C. L. Bong,[1] E. Lim,[2] J. C. Allen,[3] W. L. H. Choo,[4] Y. N. Siow,[1] P. B. Y. Teo[5] and J. S. K. Tan[2]

1 Consultant, 2 Senior Consultant, Department of Paediatric Anaesthesia, 4 Senior Staff Nurse, 5 Nurse Manager, Department of Diagnostic Imaging, KK Women's and Children's Hospital, Singapore
3 Assistant Professor, Centre for Quantitative Medicine, Office of Clinical Sciences, Duke-NUS Graduate Medical School, Singapore

Summary
Emergence delirium is a significant problem in children regaining consciousness following general anaesthesia. We compared the emergence characteristics of 120 patients randomly assigned to receive a single intravenous dose of dexmedetomidine 0.3 μg.kg⁻¹, propofol 1 mg.kg⁻¹, or 10 ml saline 0.9% before emerging from general anaesthesia following a magnetic resonance imaging scan. Emergence delirium was diagnosed as a score of 10 or more on the Paediatric Anaesthesia Emergence Delirium scale. The incidence of emergence delirium was 42.5% in the dexmedetomidine group, 33.3% in the propofol group and 41.5% in the saline group ($p = 0.671$). Three patients in the dexmedetomidine group, none in the propofol group and two in the saline group required pharmacological intervention for emergence delirium ($p = 0.202$). Administration of neither dexmedetomidine nor propofol significantly reduced the incidence, or severity, of emergence delirium. The only significant predictor for emergence delirium was the time taken to awaken from general anaesthesia, with every minute increase in wake-up time reducing the odds of emergence delirium by 7%.

Preemptive strategy

- Non pharmacologic interventions
  - Premedication
  - Parental presence, video distraction etc
  - Above measure allays anxiety but may not reduce ED
- Appropriate anaesthesia techniques
  - Good pain strategies
- Pharmacologic agents
  - Adjunct agents

Cochrane Library

Effects of sevoflurane versus other general anaesthesia on emergence agitation in children

Halothane
RR 0.51, 95% CI 0.41 to 0.63

Propofol TIVA
RR 0.35, 95% CI 0.25 to 0.51

Propofol after Sev Induction
RR 0.59, 95% CI 0.46 to 0.76

David Costi et al
Cochrane Database of Systematic Reviews, Sept 2014

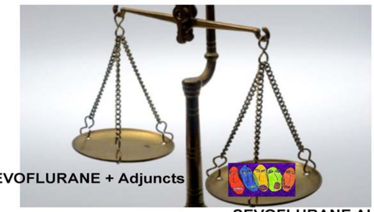
TIVA only?

INTERVENTIONS
Elective adjuncts for reducing the risk of EA during sevoflurane anaesthesia

Dexmedetomidine,
851 participants
RR 0.37, 95% CI 0.29 to 0.47

Clonidine
739 participants
RR 0.45, 95% CI 0.31 to 0.66

Opioids, in particular fentanyl
1247 participants
RR 0.37, 95% CI 0.27 to 0.50



David Costi et al
Cochrane Database of Systematic Reviews, Sept 2014

Adjuncts for reducing EA during sevoflurane anaesthesia

Effective Medication	Dosage	Route/Timing of Admin
Dexmedetomidine	1-2 ug/kg 0.5-1.0 ug/kg 0.2 ug/kg/hr	IN premed IV intraop/End IV infusion
Clonidine	2 ug/kg	IV intraop/End
Fentanyl Remifentanil	1-2 ug/kg 0.05-0.015 ug/kg/min	IV intraop/End IV intraop
Propofol *	2 - 3 mg/kg	IV/End
Ketamine*	0.25mg/kg	IV/End
Melatonin	0.2 - 0.4mg/kg	Oral premed

*Costi: Paediatric Anaesth. 2015 May:25(5):517-23.

SUMMARY

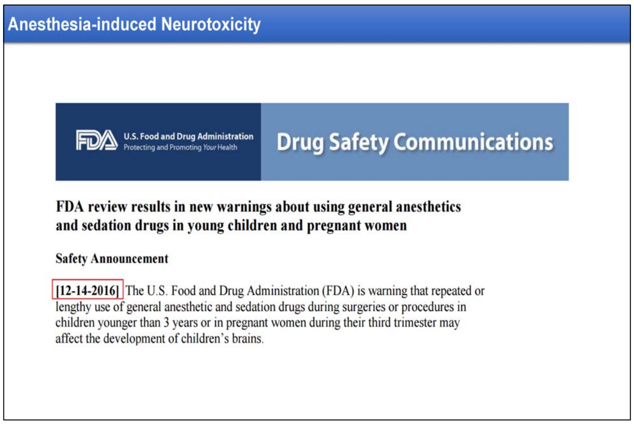
Prevention:
Identify at risk child
- Consider sedation premedication
- **EFFECTIVE** prevention of postoperative pain and nausea and vomiting
- Recover the child in a silent environment
- Avoid verbal and physical stimulation during transfer and recovery

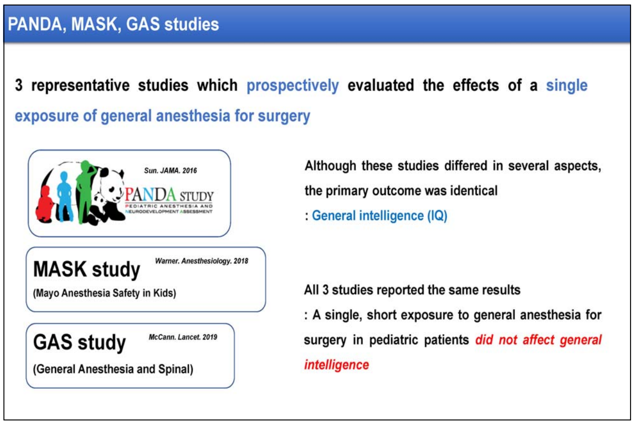
Child at risk
- Consider TIVA
- If volatiles used, use adjuncts

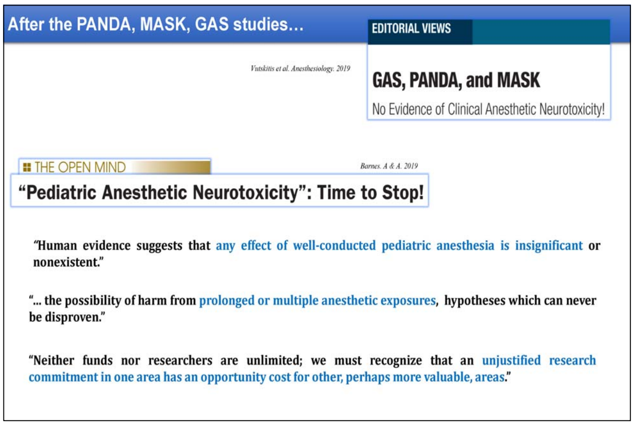
Anesthesia-induced Neurotoxicity: Recent Updates and Preclinical Research Trends

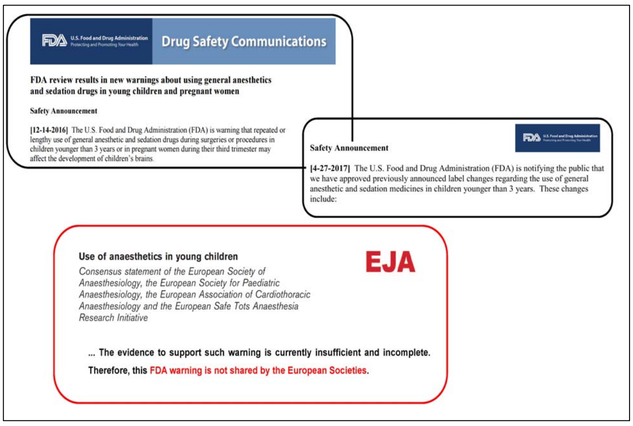
Woosuk Chung

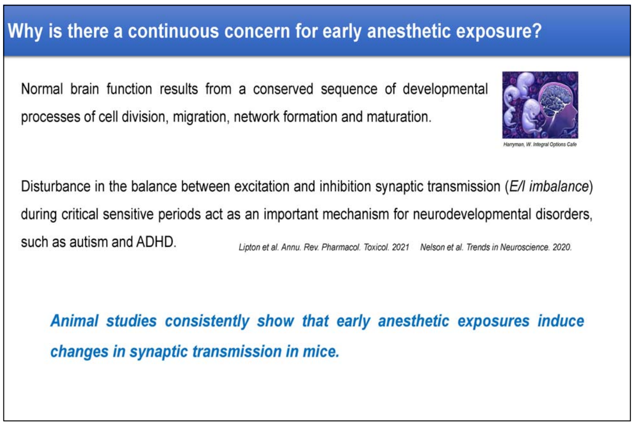
Department of Anesthesiology and Pain Medicine, Chungnam National University, Korea

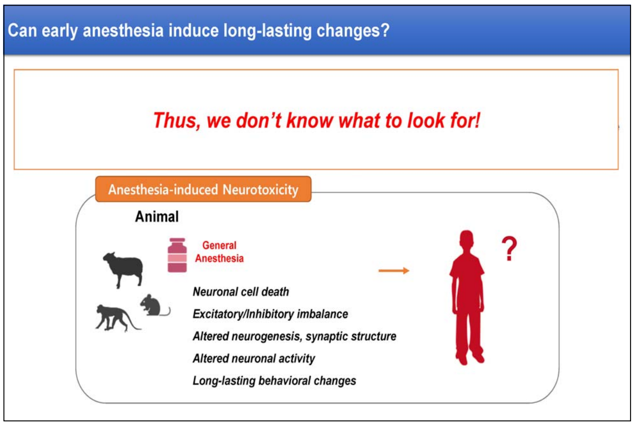












Is there a phenotype for Anesthesia-induced Neurotoxicity?

Early clinical studies mostly focused on intelligence, academic achievements (based on animal studies and general concerns).

More recent studies have performed wide-range of tests, trying to identify a possible phenotype due to early anesthetic exposure.

: Educational Outcomes, Cognitive functions, Motor abilities, Social and Behavioral outcomes, etc

Several studies suggest that although early anesthesia does not alter general cognitive function (intelligence), but it may *affect specific behaviors.* *Warner. Anesthesiology. 2018* *Anesthesiology. 2020. Walkden et al.*

Recent studies suggest possible changes in specific behaviors

Prospectively assessed neurodevelopmental outcomes in studies of anaesthetic neurotoxicity in children: a systematic review and meta-analysis

BJA. 2021. Ing et al.

A meta-analysis was performed using the results of PANDA, MASK, GAS

Child Behavior Checklist (CBCL)

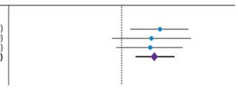
: a checklist for the parents (118 questions), detect emotional and behavioral problems in children.

Increased behavioral problems in patients who received early anesthesia

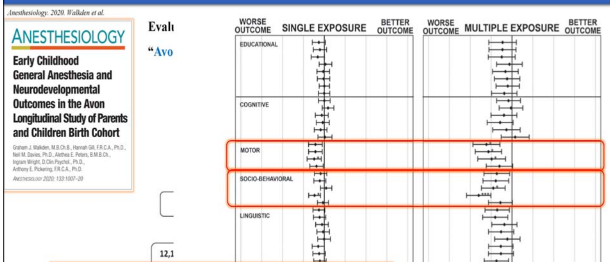
Full-scale intelligence quotient and parentally assessed outcomes

Study	Exposed n	Unexposed n	Weight (%)	Difference (95% CI)
CBCL total				
PANDA[7]	101	101	43.8	2.7 (0.6 to 4.7)
MASK[8]	380	411	23.2	2.1 (−0.7 to 4.9)
GAS[6]	356	287	33.0	2.0 (−0.4 to 4.3)
Overall	**837**	**799**	**100**	**2.3 (1.0 to 3.7)**

Cochrane's Q=0.23 df=2 P=0.89 I^2=0%
*Test for overall difference z=3.39 P=0.001**



Recent studies suggest possible changes in specific behaviors



Conclusions: Early childhood general anesthesia and surgery were not associated with a global picture of clinically and statistically significant neuro-degenerative effects, providing reassurance about the neurotoxic potential of general anesthesia. Exposure to anesthesia and surgery was associated with significantly lower motor and social linguistic performance.

Based on these recent updates, what should be considered when studying anesthesia induced neurotoxicity in young animals?

1. What is the appropriate age of animals to study anesthesia-induced neurotoxicity?

2. Could there be other phenotypes caused by early anesthetic exposures?

3. Are we using an appropriate anesthetic depth in young animals?

Based on these recent updates, what should be considered when studying anesthesia induced neurotoxicity in young animals?

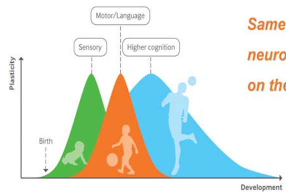
1. ***What is the appropriate age of animals to study anesthesia-induced neurotoxicity?***

2. Could there be other phenotypes caused by early anesthetic exposures?

3. Are we using an appropriate anesthetic depth in young animals?

Anesthetic exposure during neurodevelopment

The effects of early anesthesia may differ depending on the developing stage of the child.



McCann et al. BMJ. 2019
Nelson et al. Trends in Neuroscience. 2020

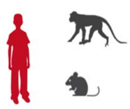
Same anesthetic exposures may affect neurodevelopment differently depending on the age of patients.

Anesthetic exposure during neurodevelopment: What to consider?

Most concerns about anesthetic induced developmental neurotoxicity has been focused on toddlers and infants because this is a time of critical development.

Thus, it is natural that preclinical research should also study animals with similar neurodevelopment compared to human infants.

Is it possible to compare the neurodevelopment between humans and animals (mice, primates)?



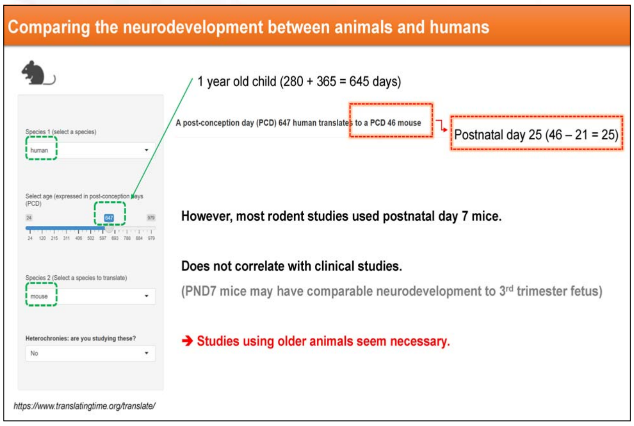
Comparing the neurodevelopment between animals and humans

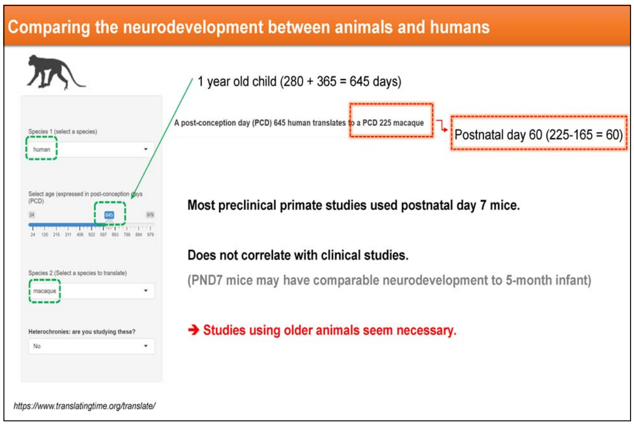
A scientific approach would be comparing important neurodevelopmental events between species…

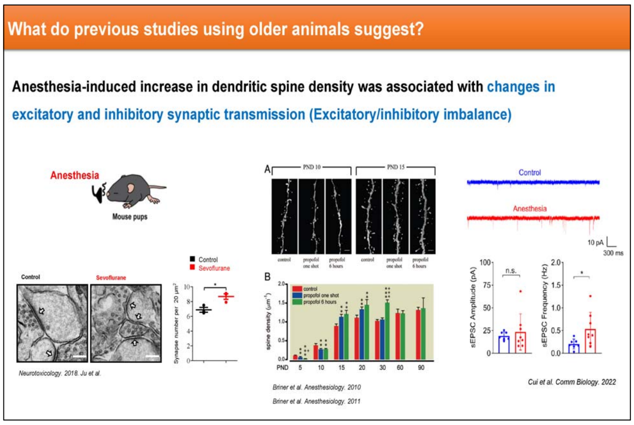
: neurogenesis, neuronal migration, axon extension, connectivity, etc

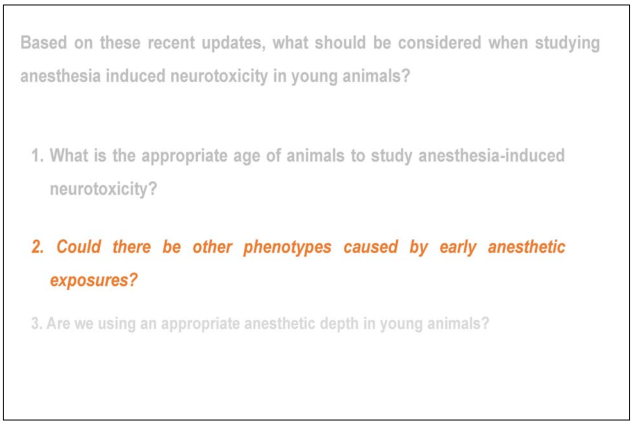
https://www.translatingtime.org/

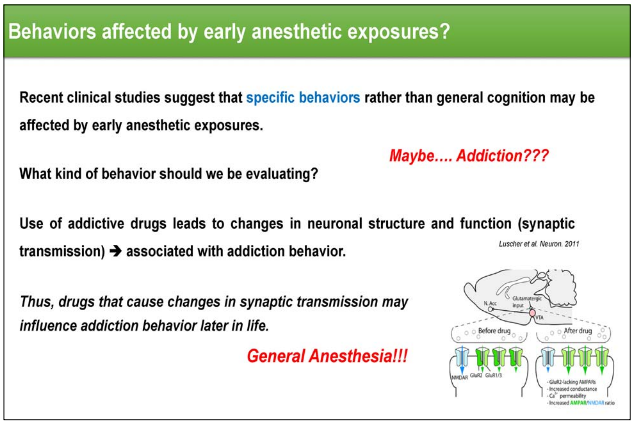
Workman. J Neuro. 2013

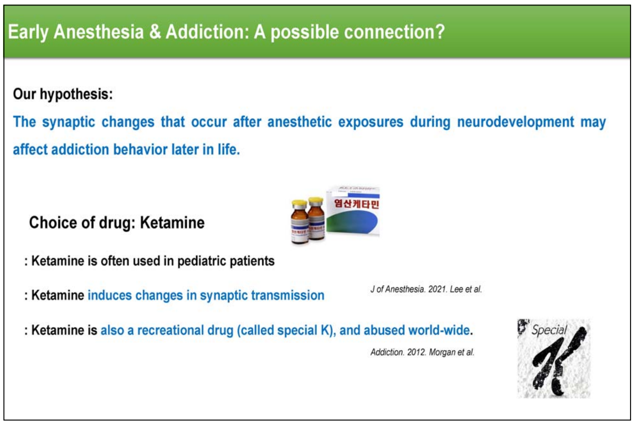

Comparing the neurodevelopment between animals and humans
1 year old child (280 + 365 = 645 days)
A post-conception day (PCD) 647 human translates to a PCD 46 mouse
Postnatal day 25 (46 – 21 = 25)
However, most rodent studies used postnatal day 7 mice.
Does not correlate with clinical studies.
(PND7 mice may have comparable neurodevelopment to 3rd trimester fetus)
➔ Studies using older animals seem necessary.
https://www.translatingtime.org/translate/

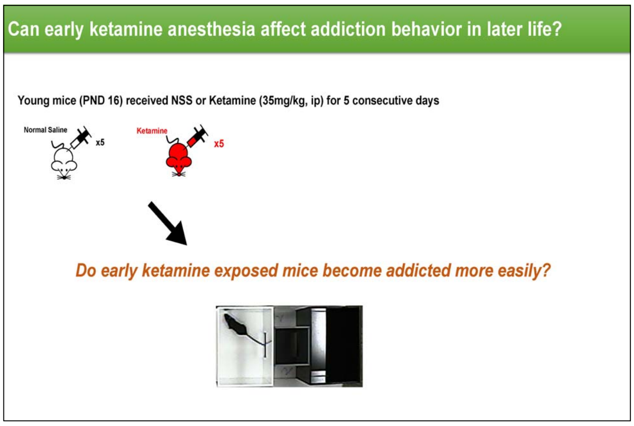

Comparing the neurodevelopment between animals and humans
1 year old child (280 + 365 = 645 days)
A post-conception day (PCD) 645 human translates to a PCD 225 macaque
Postnatal day 60 (225-165 = 60)
Most preclinical primate studies used postnatal day 7 mice.
Does not correlate with clinical studies.
(PND7 mice may have comparable neurodevelopment to 5-month infant)
➔ Studies using older animals seem necessary.
https://www.translatingtime.org/translate/

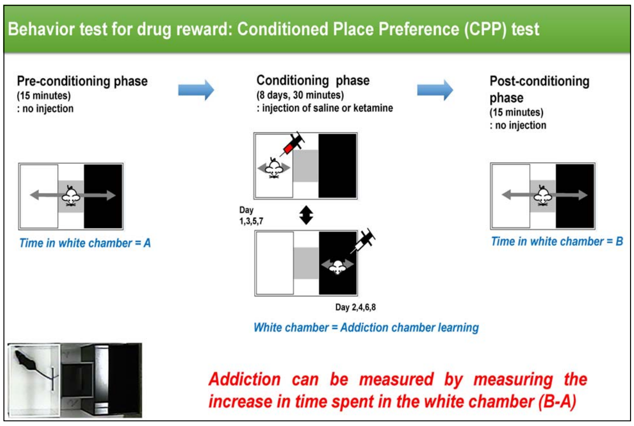

What do previous studies using older animals suggest?
Anesthesia-induced increase in dendritic spine density was associated with changes in excitatory and inhibitory synaptic transmission (Excitatory/inhibitory imbalance)
Anesthesia
Mouse pups
Control
Sevoflurane
Neurotoxicology. 2018. Ju et al.
Control
Anesthesia
Briner et al. Anesthesiology. 2010
Briner et al. Anesthesiology. 2011
Cui et al. Comm Biology. 2022


Based on these recent updates, what should be considered when studying anesthesia induced neurotoxicity in young animals?
1. What is the appropriate age of animals to study anesthesia-induced neurotoxicity?
2. Could there be other phenotypes caused by early anesthetic exposures?
3. Are we using an appropriate anesthetic depth in young animals?

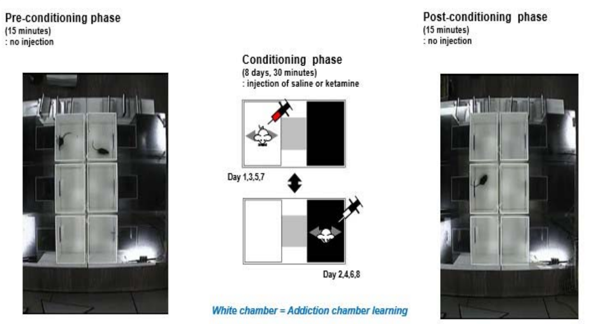

Behaviors affected by early anesthetic exposures?
Recent clinical studies suggest that specific behaviors rather than general cognition may be affected by early anesthetic exposures.
Maybe.... Addiction???
What kind of behavior should we be evaluating?
Use of addictive drugs leads to changes in neuronal structure and function (synaptic transmission) ➔ associated with addiction behavior.
Luscher et al. Neuron. 2011
Thus, drugs that cause changes in synaptic transmission may influence addiction behavior later in life.
General Anesthesia!!!
Before drug
After drug


Early Anesthesia & Addiction: A possible connection?
Our hypothesis:
The synaptic changes that occur after anesthetic exposures during neurodevelopment may affect addiction behavior later in life.
Choice of drug: Ketamine
: Ketamine is often used in pediatric patients
: Ketamine induces changes in synaptic transmission
J of Anesthesia. 2021. Lee et al.
: Ketamine is also a recreational drug (called special K), and abused world-wide.
Addiction. 2012. Morgan et al.
Special

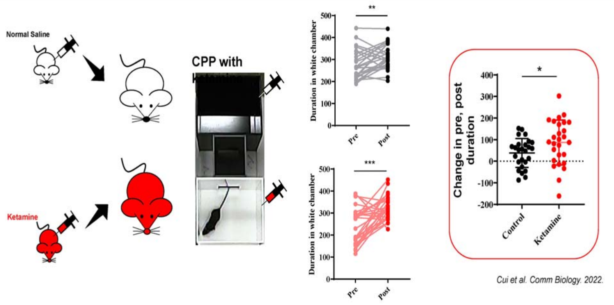

Can early ketamine anesthesia affect addiction behavior in later life?
Young mice (PND 16) received NSS or Ketamine (35mg/kg, ip) for 5 consecutive days
Normal Saline
x5
Ketamine
x5
Do early ketamine exposed mice become addicted more easily?


Behavior test for drug reward: Conditioned Place Preference (CPP) test
Pre-conditioning phase
(15 minutes)
: no injection
Conditioning phase
(8 days, 30 minutes)
: injection of saline or ketamine
Post-conditioning phase
(15 minutes)
: no injection
Time in white chamber = A
Day 1,3,5,7
Day 2,4,6,8
White chamber = Addiction chamber learning
Time in white chamber = B
Addiction can be measured by measuring the increase in time spent in the white chamber (B-A)

Behavior test for drug reward: Conditioned Place Preference (CPP) test



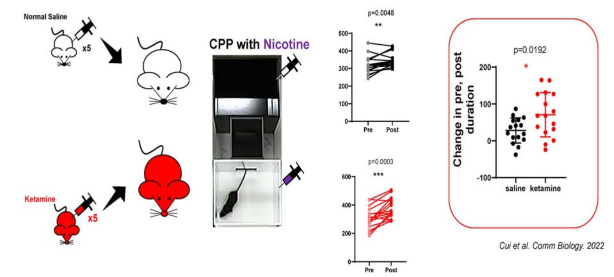
Early anesthesia increased ketamine-induced drug reward



Early ketamine injected mice show increased addiction to ketamine in later age!!!

Early anesthesia increased nicotine-induced drug reward

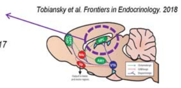
The effects could be limited to ketamine addiction. Thus, we tried another drug (nicotine).



Early ketamine injected mice show increased addiction to Nicotine in later age!!!

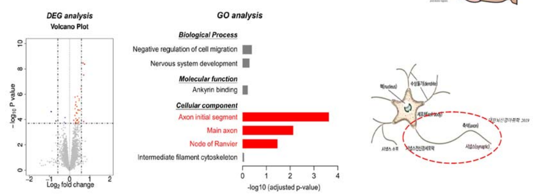
Understanding the mechanism behind the increase in drug reward

Hippocampus is involved with conditioned place preference



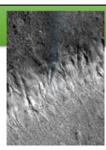
Xia et al. Cell reports. 2017

RNA sequencing using hippocampal tissue.

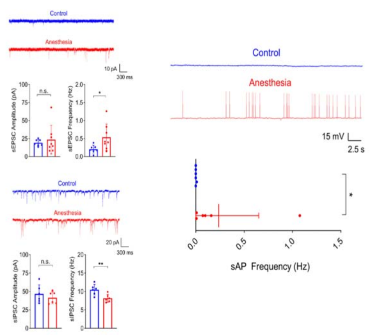


Ketamine anesthesia may cause long-lasting changes in neuronal activity, leading to increased addiction behavior!

Understanding the mechanism behind the increase in drug reward



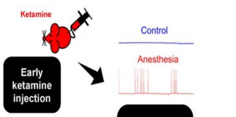
Directly measure changes in neuronal activity in the hippocampus (Electrophysiology)



Ketamine anesthesia induced long-lasting increase in neuronal activity, which may act as a mechanism for the increase in drug reward behavior!

Cui et al. Comm Biology. 2022.

Can early ketamine anesthesia affect addiction behavior in later life?



Our results suggest that early ketamine exposures increase neuronal activity, leading to long-lasting changes in drug-reward behavior later in life.

Our results suggest that future studies identifying possible changes in diverse behaviors may provide valuable insights regarding anesthesia-induced anesthesia.

Based on these recent updates, what should be considered when studying anesthesia induced neurotoxicity in young animals?

1. What is the appropriate age of animals to study anesthesia-induced neurotoxicity?
2. *Could there be other phenotypes caused by early anesthetic exposures?*
3. ***Are we using an appropriate anesthetic depth in young animals?***

Depth of anesthesia in neurotoxicity research

pEEG monitoring is widely used for controlling anesthetic depth in adult patients, and recent studies suggest the unnecessary depth of anesthesia (causing burst suppression) is associated with worse clinical outcomes.

Pawar et al. Front Syst Neurosci. 2022.

Although pEEG monitoring is unreliable in pediatric patients due to changes in EEG during neurodevelopment, previous studies show that anesthetic overdose (burst suppression) often occurs also in pediatric patients (30~60%).

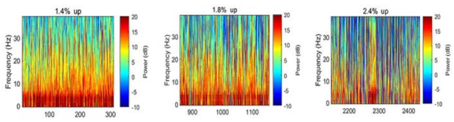
Yuan et al. Current Anesth Reports. 2023.

While long-term adverse affects of unnecessary depth of anesthesia remain undetermined, future studies may need to evaluate the appropriate anesthetic dose when studying neurotoxicity in young animals.

Depth of anesthesia in neurotoxicity research

Regarding sevoflurane, most preclinical studies use a concentration of 2.5% when studying neurotoxicity in both rodents and primates.

Sevoflurane 2.5%, when administered in PND 17 mice induces robust burst-suppression.



Ju et al. Unpublished data

Depth of anesthesia in neurotoxicity research

Is burst suppression associated long-lasting behavioral changes?

Experimental paradigm

P17

Surgery and anesthesia

8wk

Behavioral experiment

Group1 : control

Group2 : No Burst Suppression Anesthesia (Sevo 1.4%) + Surgery

Group3 : Burst Suppression Anesthesia (Sevo 2.4%) + Surgery

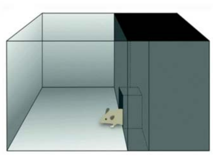
Learning and Memory, Anxiety, Sociability

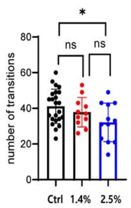
Jang et al. Unpublished data

Depth of anesthesia in neurotoxicity research

Mice that received surgery under deep anesthesia showed changed anxiety levels in the light-dark box test

Light-dark box test





Jang et al. Unpublished data

Conclusion

Evidence strongly suggests that the effects of anesthesia on general cognition is subtle.

Recent studies also suggest that early anesthetic exposures may have a more significant effect in specific aspects of development.

Thus, further studies identifying possible changes in diverse developmental behaviors may provide valuable insights regarding the potential neurotoxic effects of early anesthesia.

Also, future preclinical studies should also attempt to mirror clinical settings by considering factors such as the age of animals and the appropriate anesthetic dose.

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