Anesthésie cardiaque en dehors du bloc opératoire

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Quelle anesthésie au KT pédiatrique ?

Prérequis : - sécurité
- fiabilité des calculs et mesures
- turn-over

AG avec intubation ? Masque laryngé ? Sédation ? ALR ?

2 temps douloureux : - ponction vasculaire
- compression des points de ponction

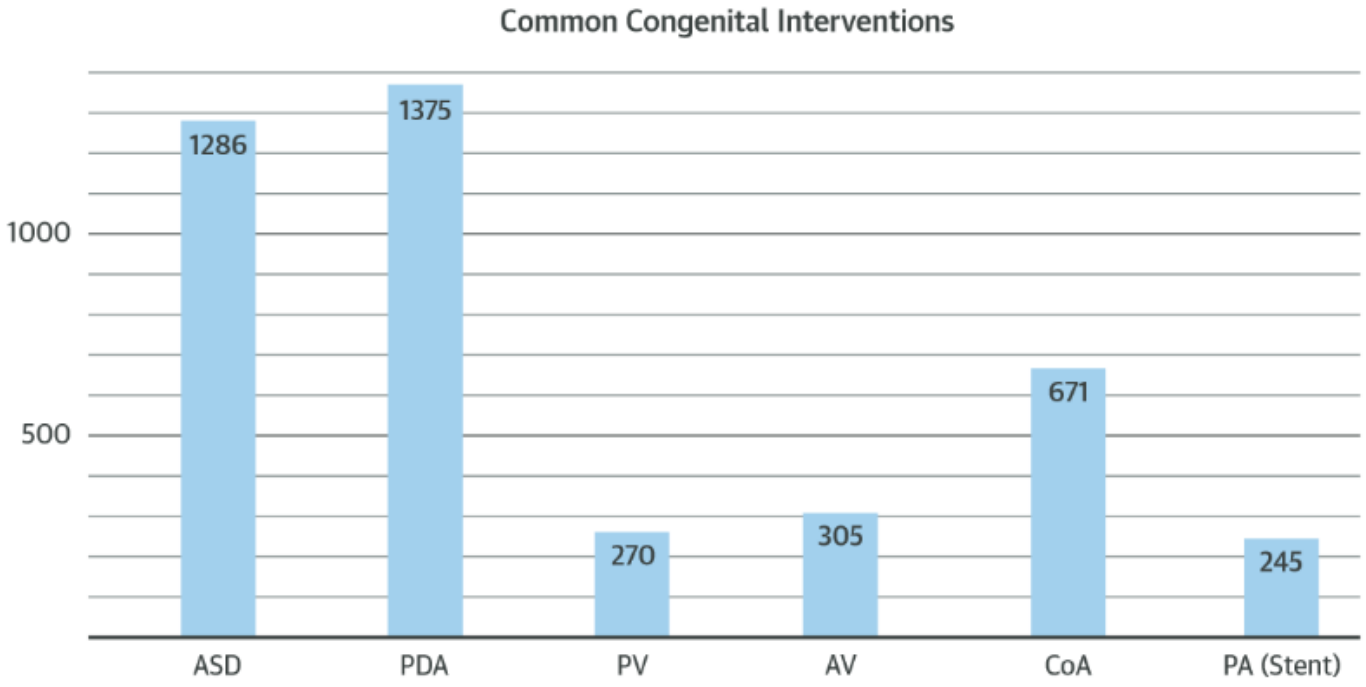
En cas d'accident … éloignement du bloc opératoire

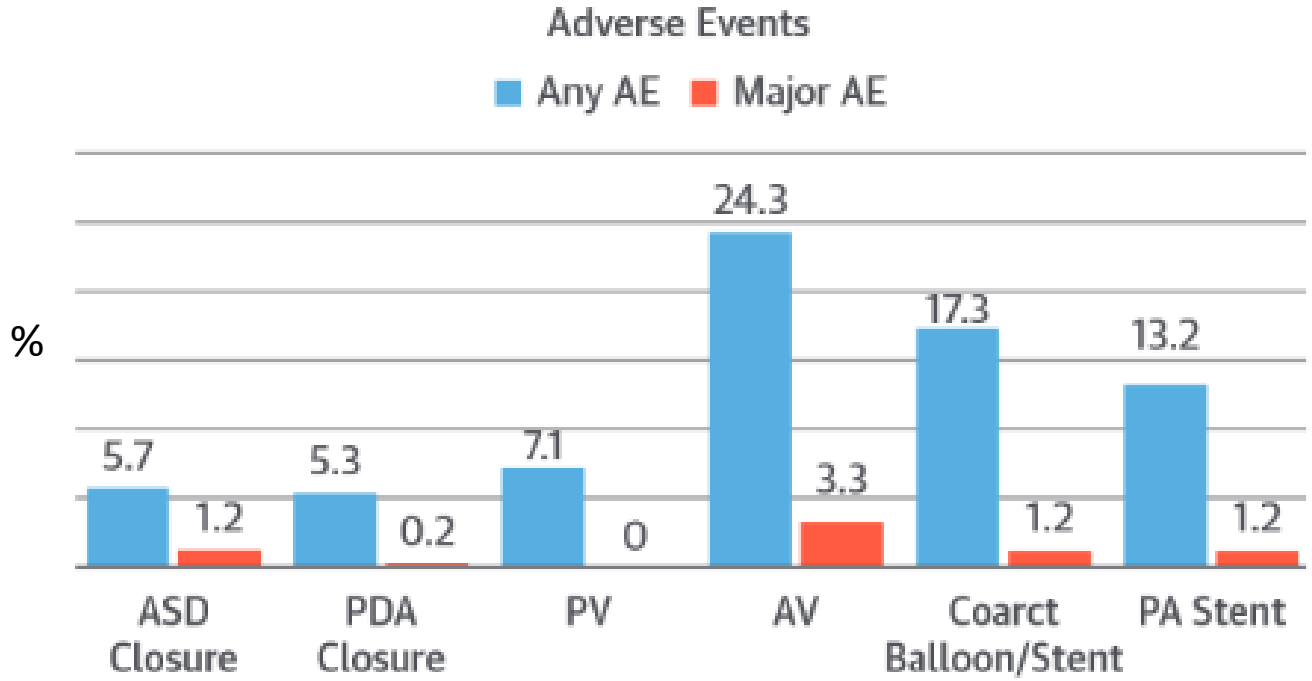
Registre IMPACT (Improving pediatric and Adult Congenital Treatment)

4152 procédures KT 2011-2013

MAE: arrêt cardiaque, tamponnade, AVC, trouble du rythme nécessitant pace

AE: arrythmie transitoire, régurgitation valvulaire, saignement/transfusion, migration/thrombose prothèse, dialyse, ECMO





	Age <30 Days (Neonates)	Age 30 Days to 1 Year (Infants)	Age 1-18 Years (Children)	Age >18 Years (Adults)
ASD	AE: 50% MAE: 0 Embolisation: 0 Surg: 0	11.8% 5.9% 0 0	5.7% 0.9% 1.8% 0.7%	5.2% 1.8% 1.5% 0.9%
PDA	AE: 40% MAE: <0.1 Embolisation: 0 Surg: 10%	8.1% <0.1 0.8% 0.3%	4.1% <0.1 1.4% 0	0 0 0 0
Pulmonary valvuloplasty	AE: 14.3% MAE: 0 Surg: 0	6.5% 0 0	2.4% 0 0	
Aortic valvuloplasty	AE: 29% MAE: 3% Surg: 1%	33.3% 2.7% 1.3%	13.5% 4.8% 1%	
CoA	AE: 35.3% MAE: 17.6% Surg: 0	25.2% 0.4% 0.8%	12.2% 1% 0.7%	 1.1% 1.1%
PA stent	AE: 33.3% MAE: 0 Surg: 0	26.3% 2.6% 0	9.2% 0.6% 0.6%	17.2% 3.4% 0

The Frequency of Cardiac Arrests in Patients with Congenital Heart Disease Undergoing Cardiac Catheterization

Odegard, Anesth Analg 2014

BOSTON 2004- 2009 : 7289 KT, 70 ACR = 0,96%

KT Interventionnel: 1,4%
KT Diag : 0,6 %
Biopsie myocardique : 0,1 %

FdR : Âge < 1 an, KT interventionnel
-> 69% resuscitation réussie (<11min)
-> 26% ECMO
-> 6% échec de la réanimation

Table 3. Catheterization Procedures Performed

Intervention	Intervention site	N (%)[a]
Devices		969 (23)
	ASD or PFO	416 (10)
	VSD	42 (1)
	Fontan baffle fenestration closure	190 (5)
	Other	321 (8)
Angioplasty		1796 (43)
	Pulmonary artery	948 (22)
	Systemic artery	284 (7)
	RVOT	285 (7)
	Pulmonary vein	185 (4)
	Other	349 (8)
Stent placement or redilation		1130 (27)
	Pulmonary artery	561 (13)
	Systemic artery	166 (4)
	RVOT	217 (5)
	Pulmonary vein	37 (1)
	Other	222 (5)
Valvotomy		482 (11)
	Mitral	60 (1)
	Pulmonary	226 (5)
	Aortic	194 (5)
	Tricuspid	9 (<1)
Coils		869 (20)
Balloon atrial septostomy		50 (1)
Atrial septum static dilation or stent placement		142 (3)

Table 7. Categorization of Causes and Outcomes at the Time of Cardiac Arrest in the Catheterization Laboratory

	Total, *n*	ROC, *n* (% discharged)	ECMO CPR, *n* (% discharged)	Died, *n*
Arrhythmia	38	30 (93)	8 (75)	0
Perforation (vascular or cardiac)	13	9 (89)	4 (50)	0
Myocardial ischemia	6	3 (100)	3 (0)	0
Hypotension	3	0	1 (0)	2
Airway or ventilation failure	4	4 (100)	0	0
Hypoxemia	6	2 (100)	2 (100)	2
Total	70	48 (94)	18 (55)	4

ROC = return of circulation; ECMO = extracorporeal membrane oxygenation; CPR = cardiopulmonary resuscitation.

AVANT

anesthesia care unit (PACU). The scheduling of cases and the decision as to whether a case should be performed by the CAS or by nurse-managed sedation was determined by the cardiologist performing the procedure. The technique for nurse-managed sedation was according to an approved protocol, with anesthesia back-up available when medication limits were reached, or when adverse events occurred.

APRES

these included a new electronic scheduling method, rules for notification about changes in the case order and additions to the schedule, and daily morning huddles between the CAS staff assigned to the catheter laboratory, interventional cardiologists, technicians, and nursing staff before any cases being started. During the morning huddle, it was jointly confirmed by the cardiology and anesthesia teams as to whether a case would need general anesthesia or could be performed with nurse-managed sedation. Staff levels

Table 8. Frequency of Cardiac Arrests and Percentage of Cases Managed by the CAS Over Time

Year group	Total cases (*n*)	Cases managed by CAS*	Cardiac arrests†	ECMO (*n*)	Died before discharge (*n*)
2004–2005	2300	1163 (51%)	34 (1.5%)	7	7
2006–2009	4989	3322 (67%)	36 (0.7%)	10	8

8 cardiologues interventionnels, 18 anesthésistes …

Catheterization for Congenital Heart Disease Adjustment for Risk Method (CHARM)

Bergensen, JACC 2011

Cohorte de 9362 cas dans 8 centres Nord-Américains, 2007-2009
C3PO = Congenital Cardiac Catheterisation Project on Outcomes

Cohortes en cours de constitution:
- MAGIC = MId-Atlantic Group of interventional Cardiology
- CCISC = Congenital Cardiovascular Interventional Study Consortium

CHARM basé sur :
1. « procedure type risk category »
2. N° d'indicateurs hémodynamiques
3. Age

Les évènements indésirables, « high-risk » > 2

Table 2. Definitions for Adverse Event Severity

Severity Level	Definition	Examples
1–None	No harm, no change in condition, may have required monitoring to assess for potential change in condition with no intervention indicated.	Balloon rupture Equipment problem
2–Minor	Transient change in condition, not life-threatening, condition returns to baseline, required monitoring, required minor intervention such as holding a medication, or obtaining laboratory test.	Groin hematoma Self-resolving arrhythmia
3–Moderate	Transient change in condition may be life-threatening if not treated, condition returns to baseline, required monitoring, required intervention such as reversal agent, additional medication, transfer to the intensive care unit for monitoring, or moderate transcatheter intervention to correct condition.	Unstable arrhythmia with preserved blood pressure requiring intervention Vascular damage not life-threatening but requiring intervention
4–Major	Change in condition, life-threatening if not treated, change in condition may be permanent, may have required an intensive care unit admission or emergent readmit to hospital, may have required invasive monitoring, required interventions such as electrical cardioversion or unanticipated intubation or required major invasive procedures or transcatheter interventions to correct condition.	Event requiring cardiopulmonary resuscitation Event leading to surgery or repeat catheterization Stroke
5–Catastrophic	Any death, and emergent surgery or heart lung bypass support (ECMO) to prevent death with failure to wean from bypass support.	Event resulting in death

Procedure type risk category

Table 1. Procedure Type Risk Categories

	Risk Category 1	Risk Category 2	Risk Category 3	Risk Category 4
Diagnostic case	Age ≥1 yr	Age ≥1 month <1 yr	Age <1 month	
Valvuloplasty		Pulmonary valve ≥1 month	Aortic valve ≥1 month Pulmonary valve <1 month Tricuspid valve	Mitral valve Aortic valve <1 month
Device or coil closure	Venous collateral LSVC	PDA ASD or PFO Fontan fenestration Systemic to pulmonary artery collaterals	Systemic surgical shunt Baffle leak Coronary fistula	VSD Perivalvular leak
Balloon angioplasty		RVOT Aorta dilation <8 atm	Pulmonary artery <4 vessels Pulmonary artery ≥4 vessels all <8 atm Aorta >8 atm or CB Systemic artery (not aorta) Systemic surgical shunt Systemic to pulmonary collaterals	Pulmonary artery ≥4 vessels Pulmonary vein
Stent placement		Systemic vein	RVOT Aorta Systemic artery (not aorta)	Ventricular septum Pulmonary artery Pulmonary vein Systemic surgical shunt Systemic pulmonary collateral
Stent redilation		RVOT Atrial septum Aorta Systemic artery (not aorta) Systemic vein	Pulmonary artery Pulmonary vein	Ventricular septum
Other	Myocardial biopsy	Snare foreign body Transseptal puncture	Atrial septostomy Recanalization of jailed vessel in stent Recanalization of occluded vessel	Atrial septum dilation and stent Any catheterization <4 days after surgery Atretic valve perforation

ASD = atrial septal defect; CB = cutting balloon; LSVC = left superior vena cava; PDA = patent ductus arteriosus; PFO = patent foramen ovale; RVOT = right ventricular outflow tract (RVOT includes right ventricle to pulmonary artery conduit or status post-RVOT surgery with no conduit); VSD = ventricular septal defect.

Les indicateurs hémodynamiques

Table 4. Potential Indicators of Hemodynamic Vulnerability and Empirically Derived Threshold Values for the Outcome High Severity AE

	Sample Size, N	Cutpoint	Patients, n (%)	Odds Ratio	95% CI	p Value
Cardiac index	6,160	<2.8	1,190 (19%)	1.5	1.1–1.9	0.009
Systemic ventricle EDP	4,909	≥18	355 (7%)	1.8	1.2–2.6	0.005
MVsat	6,619	<60 nonSV <50 SV	905 (14%)	2.6	2.0–3.4	<0.001
SAsat	6,322	<95 nonSV <78 SV	1,827 (29%)	1.9	1.5–2.4	<0.001
MPAmp	6,214	≥26 nonSV ≥17 SV	1,412 (23%)	2.0	1.6–2.6	<0.001
MPAsp	6,501	≥45 nonSV	854 (13%)	2.7	1.9–3.6	<0.001
Systolic RV	6,546	≥45 nonSV	1,865 (28%)	2.7	2.0–3.5	<0.001
RV ratio	4,923	≥0.4 nonSV	1,953 (40%)	2.0	1.4–2.8	<0.001

EDP= pression en fin de diastole (POG), Mvsat= SvO2, MPAmp= PAP moyenne, MPAsp= PAP systolique,

Exemple de calcul du risque individuel en utilisant les coefficients de régression du model multivariable:

- Intercept = -4.3588
- Catégorie de risque 2 = 0.8831
- Catégorie de risque 3 = 1.5972
- Catégorie de risque 4 = 2.0345
- 1 facteur hémodynamique = 0.3960
- ≥ 2 facteurs hémodynamiques = 0.5803
- Age < 1 an = 0.2366

pour un patient < 1 an qui bénéficie d'une intervention catégorie 2 et a un facteur hémodynamique:

Ln(p/1-p) = -4.3588 + 0.8831 + 0.3960 + 0.2366 = -2.9431

La probabilité de survenue d'un évènement indésirable grave est 0.055

Conclusions de C3PO :

- Le KT est le lieu de tous les dangers …
- 5% évènements indésirables graves
- 0.2% mortalité
- 0.96% arrêt cardiaque dont 26% finissent en ECMO
- FdR pour l’arrêt cardiaque per-procédue : KT interventionnel

Sedation and Anesthesia in Pediatric and Congenital Cardiac Catheterization: A Prospective Multicenter Experience

Lin, Ped Cardiol 2015

13611 patients du registre C3PO 2007 – 2010

69% AG (IOT ou MLA), 31% sédation en VS

→ 1.8% conversion en AG: FdR <12 mois, OR 5.2
procédure à risque (CHARM > 2), OR 10.1
support inotrope, OR 11

→ 0.7% problèmes airway: FdR < 4kg, OR 4.4
SvO2 basse, OR 2.3
comorbidités, OR 1.7

European Review for Medical and Pharmacological Sciences | 2016; 20: 1490-1494

Comparison of sedation method in pediatrics cardiac catheterization

Simsek, 2016

Ventilation spontanée, enfants CC de 5 jours à 12 ans - 20 patients par groupe
G1 = Propofol 50 mcg/kg/mn – Kétamine 25 mcg/kg/mn
G2 = Propofol 50 mcg/kg/mn – Dexémédétomidine 1 mcg/kg /10 mn puis 1 mcg/kg/h
G3 = Dexémédétomidine 1 mcg/kg /10 mn puis 1 mcg/kg/h - Kétamine 25 mcg/kg/mn
G4 = Midazolam 0.1 mg/kg/h - Kétamine 25 mcg/kg/mn

	Group 1 median (min-max)	Group 2 median (min-max)	Group 3 media (min-max)	Group 4 median (min-max)	Total
Convulsion	–	1 (5.0%)	–	–	1 (3.2%)
Laryngospasm	2 (10%)	–	–	3 (15%)	5 (16.1%)
Bradycardia	1 (5%)	–	1 (5%)	1 (5%)	3 (9.7%)
Agitation	–	1 (5%)	–	1 (5%)	2 (6.5%)
Hiccup	–	–	–	2 (10%)	2 (6.5%)
Shivering	–	–	–	–	–
İncreased oral secretion	3 (15%)	5 (25%)	2 (10%)	7 (35%)	17 (54.8%)
Nausea and vomiting	–	–	–	–	–
Allergy	–	1 (5%)	–	–	1 (3.2%)
Total	6 (19.4%)	8 (25.8%)	3 (9.7%)	14 (45.1%)	31 (100%)

Effets secondaires : le moins DXM-K, le plus : MDZ-K
Meilleur niveau de sédation : PPF - K
Moins de désaturations : DXM - K
Réveil : le plus lent MDZ - K

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G1 = Propofol 50 mcg/kg/mn – Kétamine 25 mcg/kg/mn
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G4 = Midazolam 0.1 mg/kg/h - Kétamine 25 mcg/kg/mn

	Group 1	Group 2	Group 3	Group 4	*p*
HR increase > 20% compared with baseline	39 (27.9%)	2 (1.4%)	17 (12.1%)	40 (28.6%)	< 0.001
HR decrease > 20% compared with baseline	1 (1.0%)	23 (18.9%)	13 (12.3%)	2 (2.2%)	< 0.001
MAP increase > 20% compared with baseline	2 (1.4%)	9 (6.4%)	5 (3.6%)	1 (0.7%)	–
MAP decrease > 20% compared with baseline	44 (31.4%)	41 (29.3%)	47 (33.6%)	51 (36.4%)	0.620
sPO_2 decrease > 5% compared	16 (11.4%)	5 (3.6%)	1 (0.7%)	10 (7.1%)	0.001

Sédation au KT cardiaque pédiatrique

- Place très réduite. Nécessite une excellente collaboration avec le cardiologue. Bien peser les indications

- Difficile de maintenir une stabilité ventilatoire. Ampli souvent très proche de la tête

- Pas pour le KT interventionnel

- Intérêt de la Dexmédétomidine 0.5-1 µg/kg sur 10 mn puis 0,7-1mcg/kg/h associée à une analgésie (Rémifentanil ou ALR) ou à la Kétamine

Tobias, Pediatr Crit Care Med 2012

Sédation par des non – anesthésistes

« Conscious sedation of children with propofol is anything but conscious »

Reeves, Pediatrics 2004

Non simultanéité des actions

Sédater est facile, prévoir et réagir aux complications l'est moins

Former les collègues, médecins et infirmier(e)s

Intérêt du N_2O

SÉCURITÉ RADIOLOGIQUE

Table 2 Recommended dose limits for occupational exposure in x-ray imaging

Dose quantity	Occupational dose limit[a]
Effective dose	20 mSv/year averaged over 5 consecutive years (100 mSv in 5 years), and 50 mSv in any single year
Equivalent dose in	
Ocular lens[b]	150 mSv/year
Skin[c]	500 mSv/year
Hands and feet	500 mSv/year

ICRP, International Commission on Radiological Protection. Adapted from ICRP [8].

[a] Dose limits can be different in national regulations.

[b] This limit is currently being reviewed by an ICRP Task Group.

[c] Averaged over 1 cm^2 of the most highly irradiated area of the skin.

Table 3 Average radiation doses

Diagnostic modality	Effective radiation dose (mSv)
Standard chest x-ray	0.02
C-spine x-ray	0.3
Abdomen x-ray	0.53
Pelvis/hip x-ray	0.83
Thoracic spine x-ray	1.4
Lumbar spine x-ray	1.8
Head CT	2.0
Abdominal CT	10
Chest CT	10–40

CT, computed tomography. Adapted with permission from [14].

- Penser aux yeux
- L'anesthésiste peut recevoir une dose 3 fois plus importante au niveau de l'œil que l'interventionniste

Anastasian et al. Anesthesiology 2011;114:512-20

- Être toujours éloigné du tube de RX le plus possible

>1mètre

L'IRM / le scanner cardiaque

Discuter les indications : doit être utile au patient
Danger si risque d'HTAP
Problématique de l'apnée (alfentanil, remifentanil) :

- Est elle indispensable ? Techniques alternatives...à quel prix ?
- Est elle faisable ? : Non si enfant déjà très désaturé
  Non si HTAP sévère
  Non si enfant obstructif

Problématique de la bradycardie (opiacés, esmolol)
Pas d'AG avant 3 mois : emmaillotage
99% en VS, lunettes O2
Propofol 15 mg / kg / h après titration de 2-3 mg/kg, ou AIVOC
Dexmedetomidine

Electrophysiologie

AG IOT, car durée souvent importante et nombreux troubles du rythme

Opiacés pour l’induction puis attention à ne pas empêcher la recherche des foyers ectopiques

Dexmedetomidine a priori non conseillée (antiarythmogène)

TAKE HOME MESSAGES

Le Hors Bloc est toujours un endroit dangereux pour faire de l’anesthésie : se préparer et préparer le lieu en conséquence

Le KT est le plus dangereux

Bien communiquer avec les autres intervenants

Toujours savoir ce qu’on va faire, quand, pourquoi, comment

Ces examens sont difficiles : soyez AIDANT

Penser à se protéger des rayons