

Groupement Hospitalier de Territoire
Grand Paris Nord-Est
Aulnay-sous-Bois - Le Raincy-Montfermeil - Montreuil



ASSISTANCE
PUBLIQUE



HÔPITAUX
DE PARIS



Université de Paris

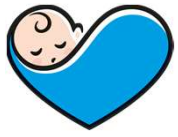


Hôpital Robert-Debré AP-HP

Indication du monitoring en pédiatrie

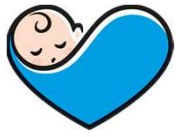
Pr Souhayl DAHMANI

DAR Hôpital Robert Debré. Paris & DAR Hôpital Robert Ballanger. Aulnay-Sous-Bois

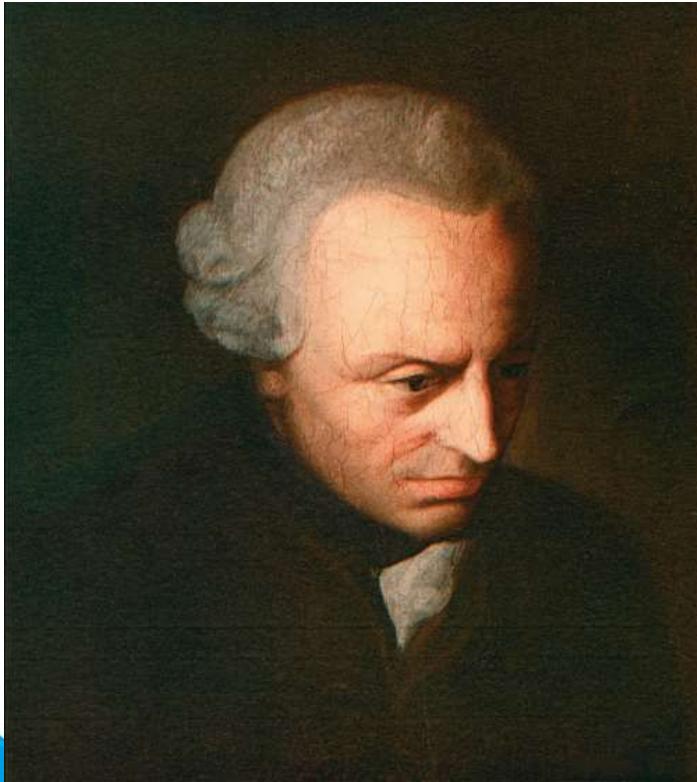


Conflits d'intérêt

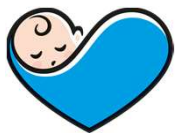
Medtronic®



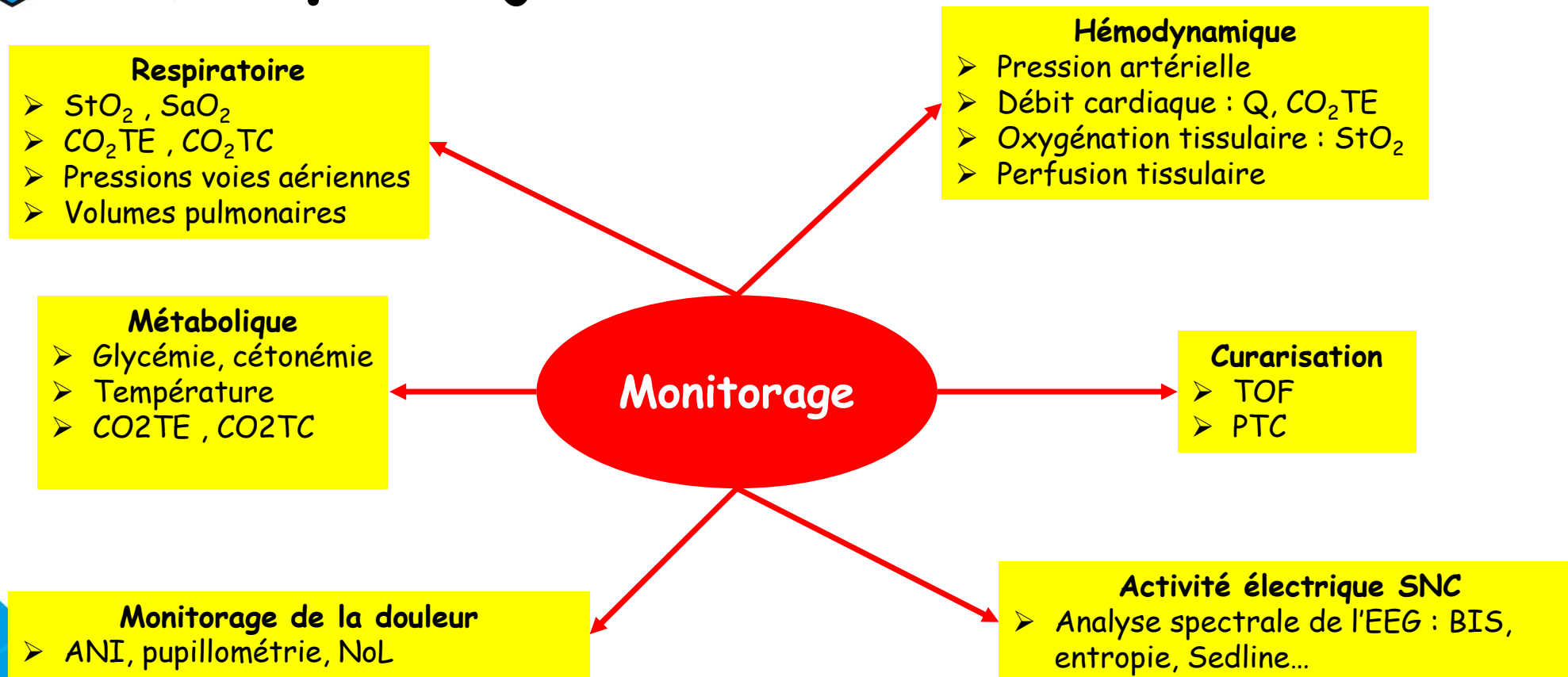
Il y a 300 ans....



- Que puis-je savoir ?
- Que dois-je faire ?
- Que m'est-il permis d'espérer ?



Que puis-je savoir ?



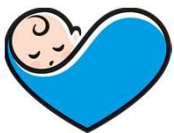


Pression artérielle

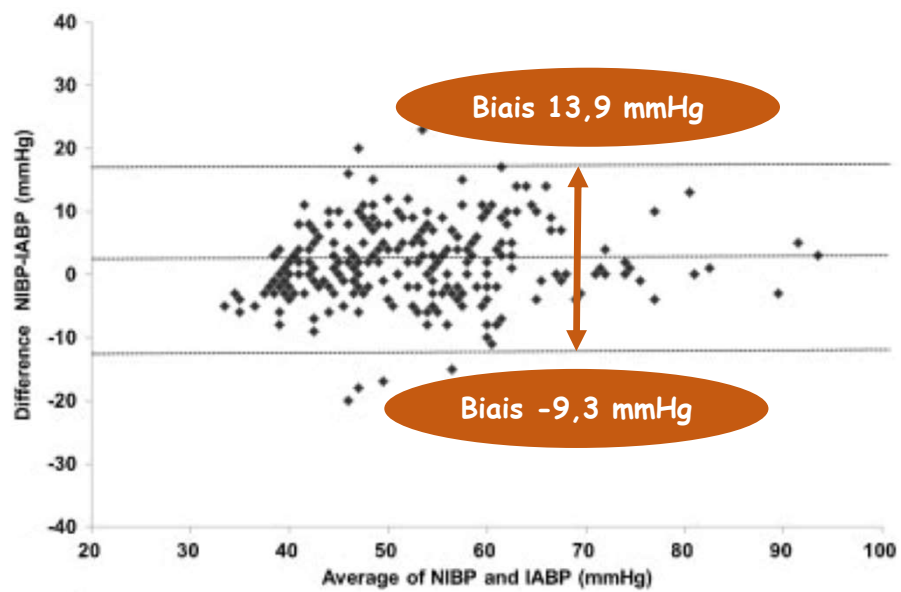
	AUC	Cut off (mmHg)	Sensitivity (%)	95% CI	Specificity (%)	95% CI
MAP under anesthesia						
All the population	0.904	39	78	71–84	90	69–98
Children <6 months	0.808	33	71	58–81	83	58–96
Children >6 months	0.944	43	83	75–90	100	30–100
	AUC	Cut off (%)	Sensitivity (%)	95% CI	Specificity (%)	95% CI
MAP variation						
All the population	0.8	–37	75	68–82	76	52–91

SBP	AUC	J point	Se J	Sp J	Gray zone
All patients	0.79 [0.74 - 0.84]	28.5 %	0.7 [0.6 - 0.8]	0.75 [0.72 - 0.77]	20.5 % - 37.5 %
Preterm	0.84 [0.77-0.88]	31.5 %	0.74 [0.6 - 0.8]	0.74 [0.7 - 0.78]	32.5 % - 39.5 %
Term	0.76 [0.7 - 0.83]	28.5 %	0.63 [0.57 - 0.80]	0.7 [0.77 - 0.8]	20.5 % - 36.5 %
MBP	AUC	J point	Se J	Sp J	Gray zone
All patients	0.67 [0.6 - 0.75]	40.5 %	0.4 [0.33 - 0.59]	0.83 [0.81 - 0.86]	15.5 % - 44.5 %
Preterm	0.72 [0.6-0.83]	40.5 %	0.5 [0.3 - 0.7]	0.8 [0.74 - 0.85]	30.5 % - 47.5 %
Term	0.65 [0.55 -0.75]	42.5 %	0.4 [0.3 - 0.6]	0.87 [0.85 - 0.9]	13.5 % - 42.5 %

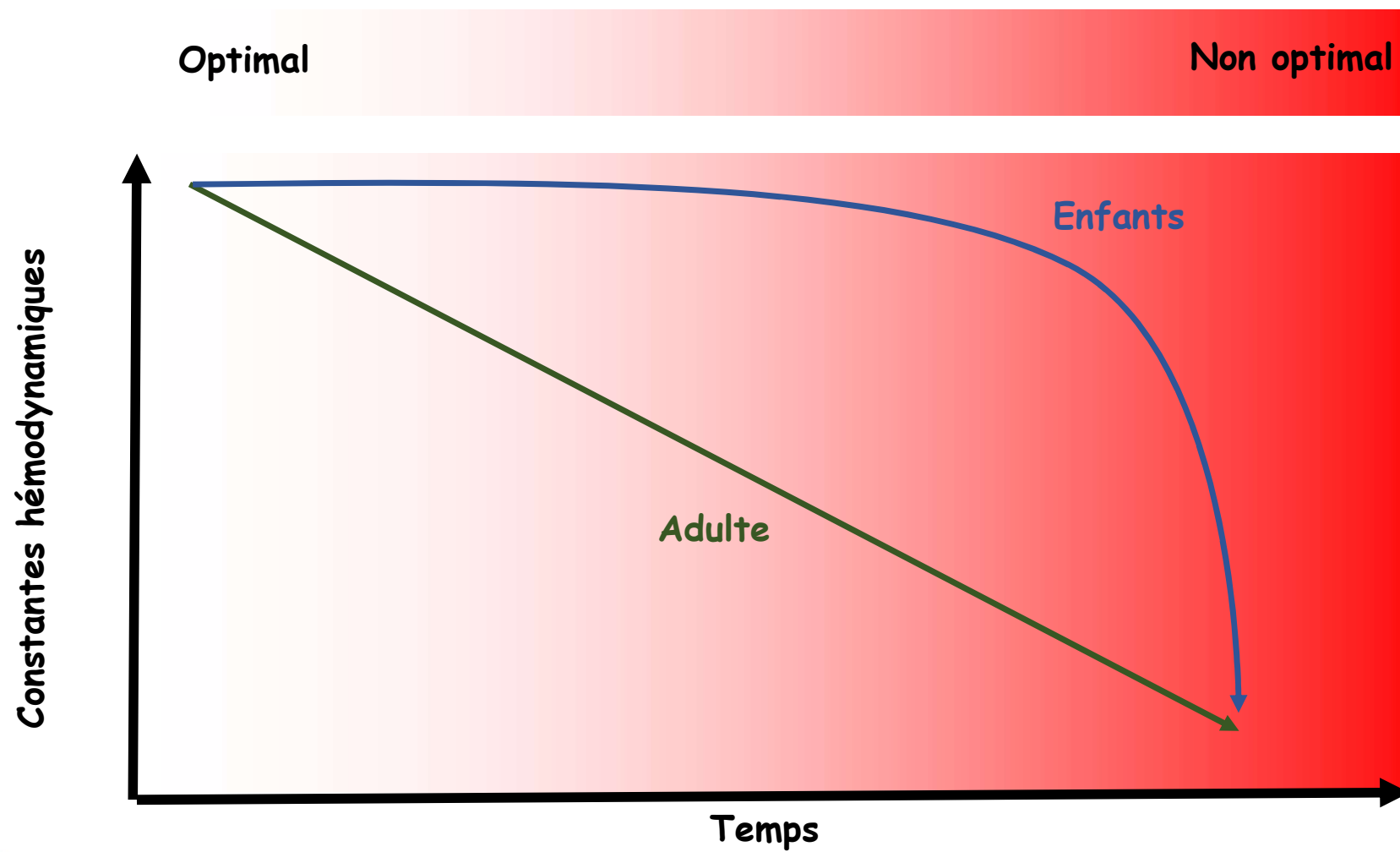
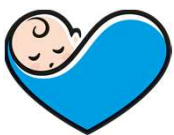
Rhondali O et al. *Pediat Anesth* 2014.
Michelet D et al. *Pediat Anesth* 2015.

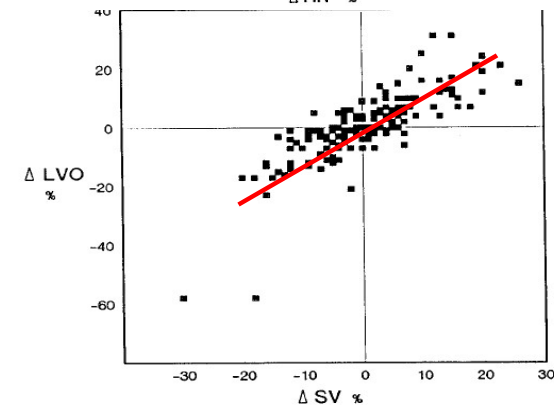
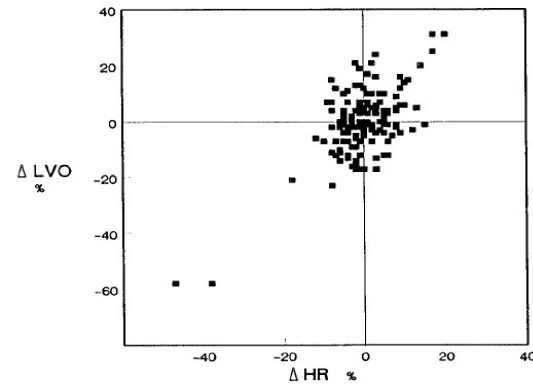
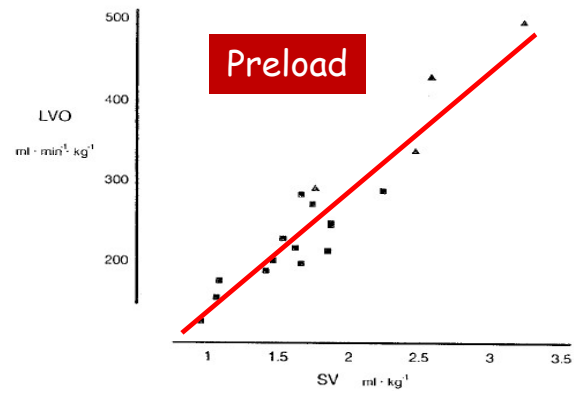
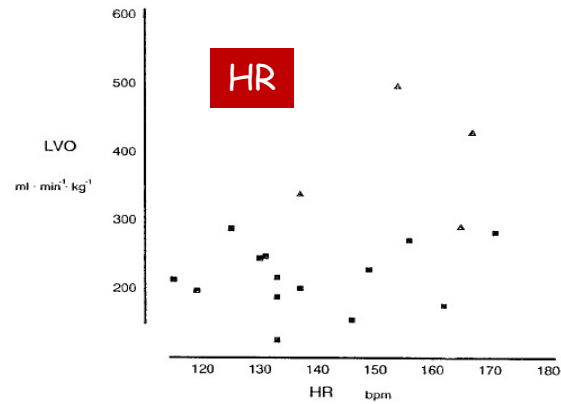


	<i>n</i> (%)
Gestational age (wk)	31.2 ± 5.8
Age at measurement (d), median (IQR)	2.0 (1.0–4.0)
Male	36 (48.6)
Body weight (g), median (IQR)	1453 (916–2204)
Heavy for gestational age	3 (4.1)
Light for gestational age	10 (13.5)



Shimokaze T et al, Am L Perinatol 2015

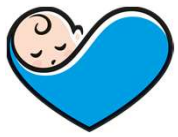




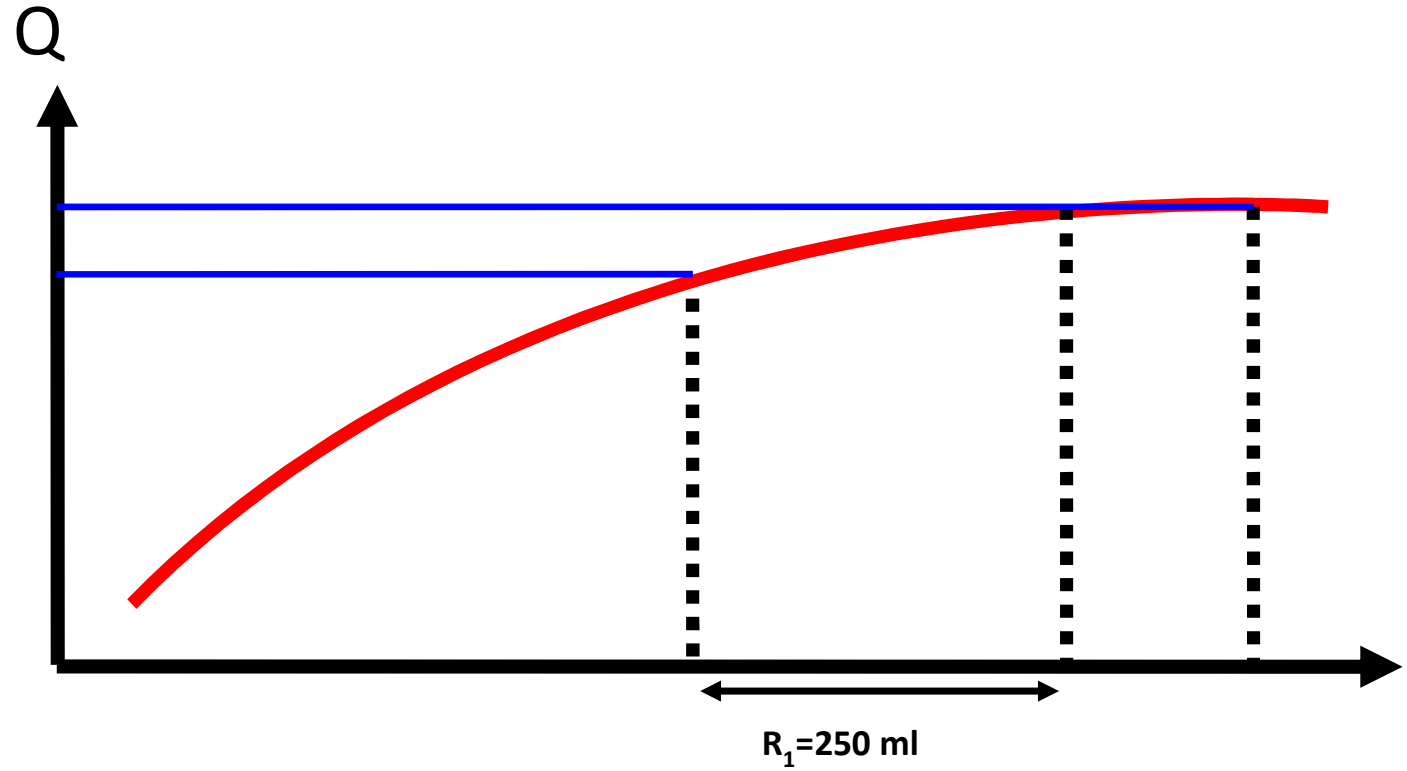
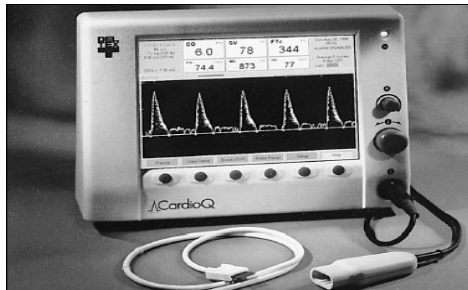
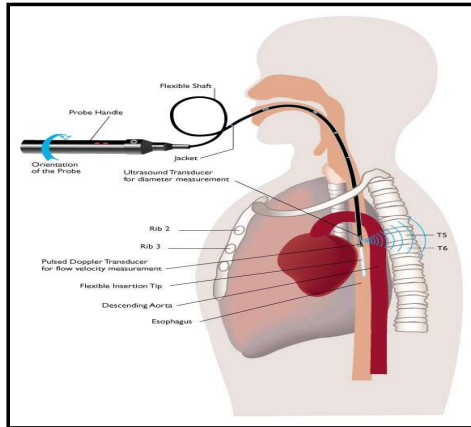
Dépendance du DC à
la FC ?

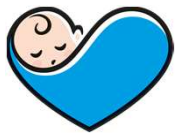
Nourrissons de 29 SA
Age 10 JPN

Winberg P et al. Pediat Resear 1992.

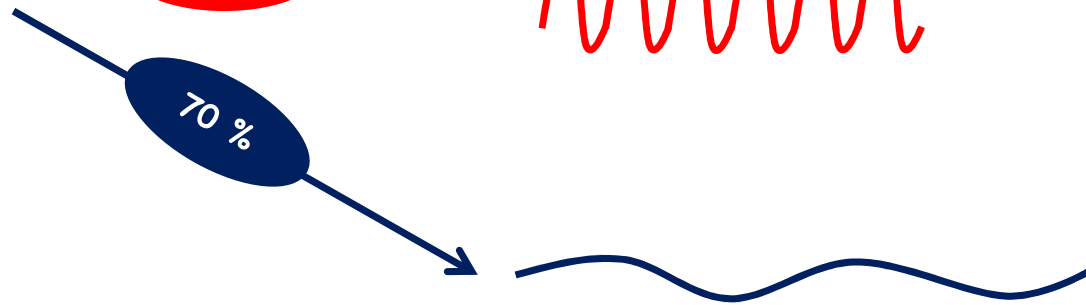
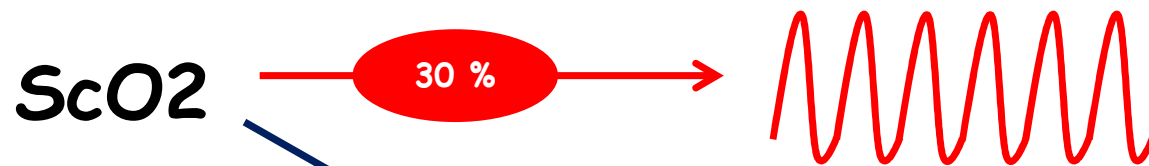
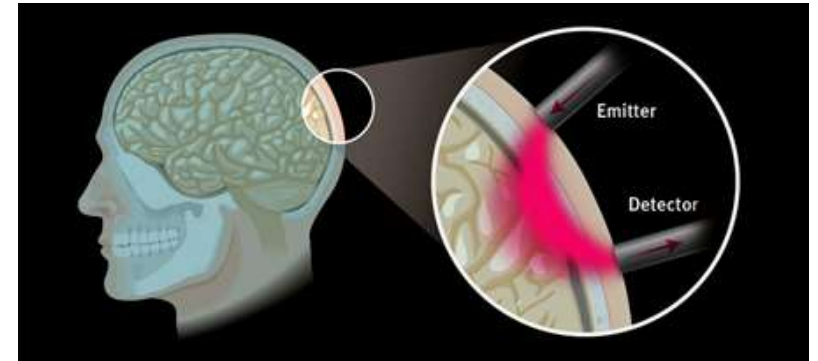


Doppler esophagien

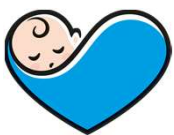




Spectroscopie Proche de l'infra-rouge (NIRS)



$$SvO_2 = SaO_2 - \left[\frac{VO_2}{Q \times Hb \times 1,34} \right]$$



DSC

ScO₂

PAM



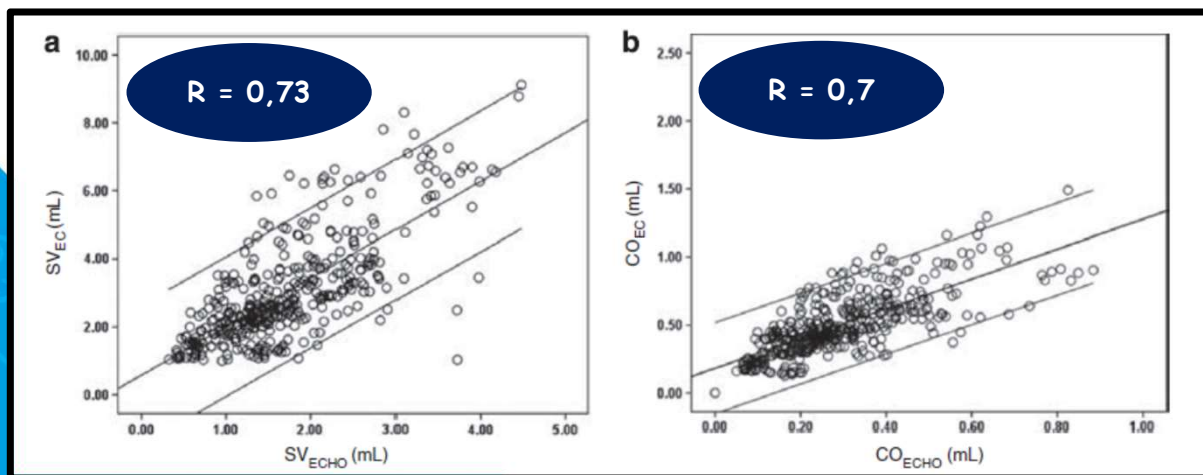
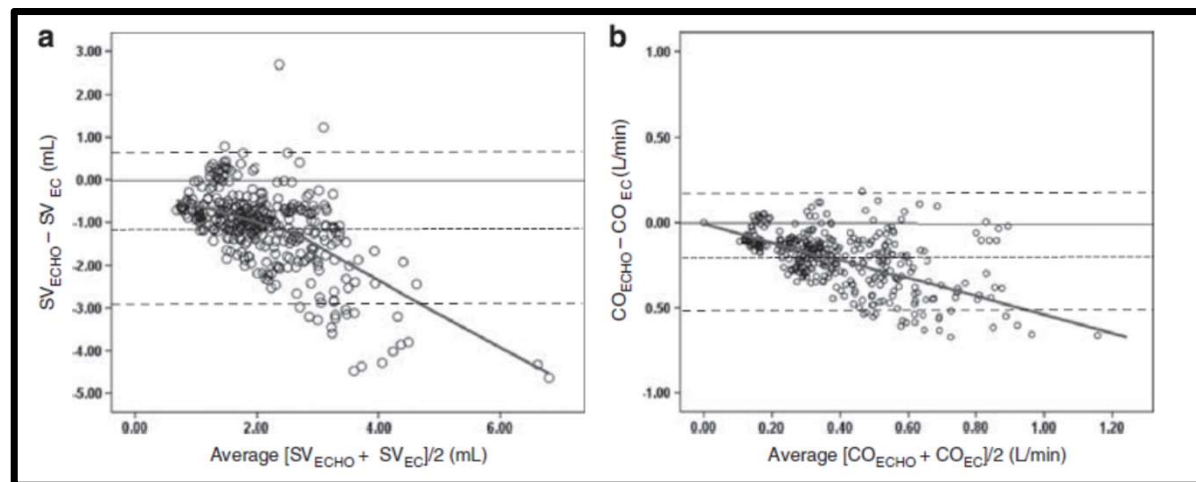


Bioimpédance

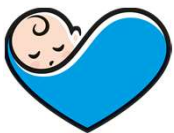
Table 1. Basic population details

Neonates	79
Males	50 (63%)
Gestational age (weeks)	31 ± 3.2
Gestational age (min-max weeks)	26-36
Birth weight (g)	1440 ± 533
SGA babies	13 (16.4%)
C-section	36 (45%)
5-min Apgar	8.2 ± 1.9
CRIB-II	8.6 ± 4

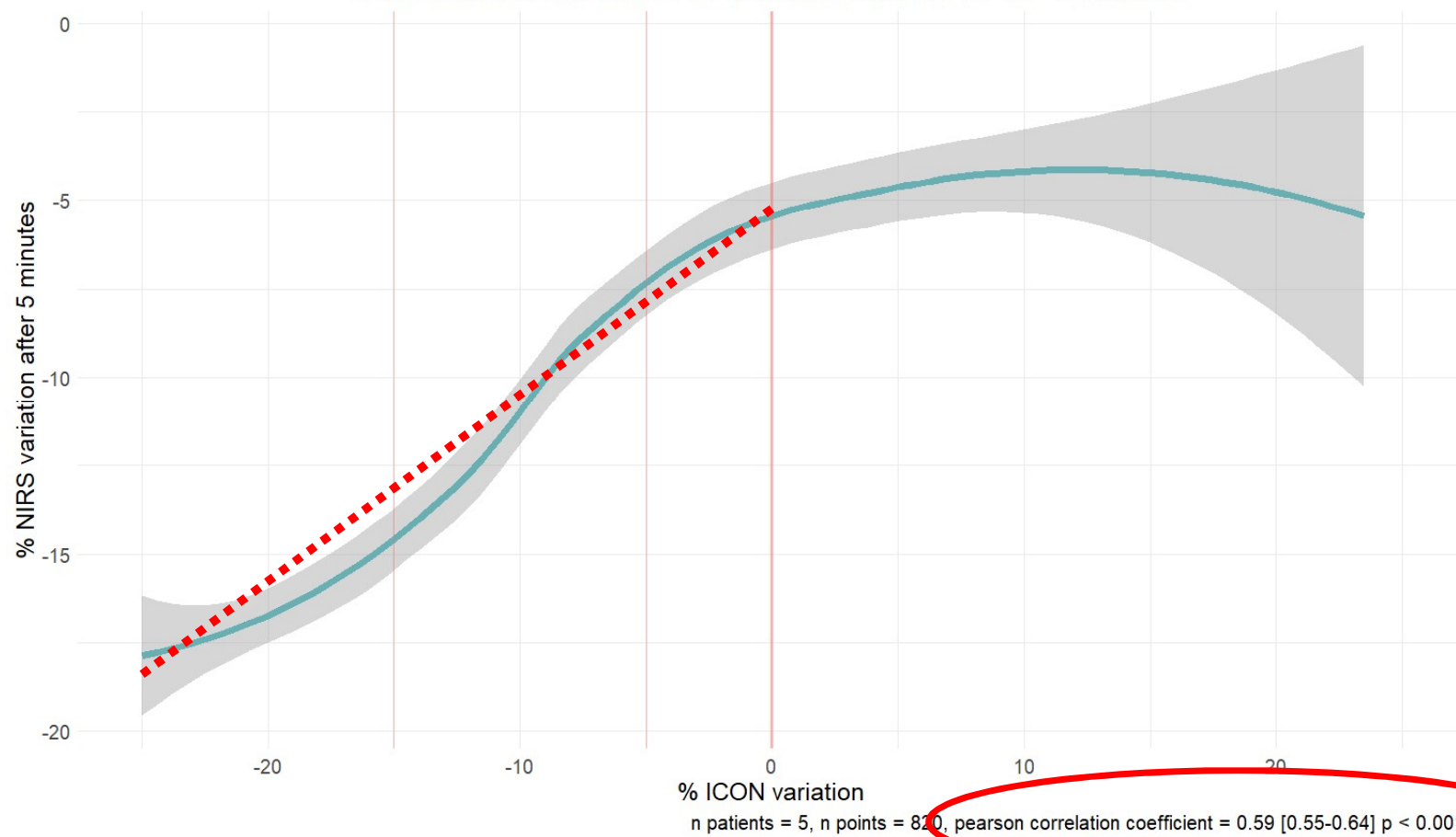
Abbreviations: CRIB-II, critical risk index for babies-II; SGA, small for gestational age. Data are expressed as mean ± s.d., number (%) or min-max value.

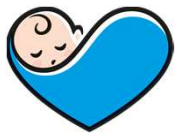


Boet A et al. J Perinatol 2015



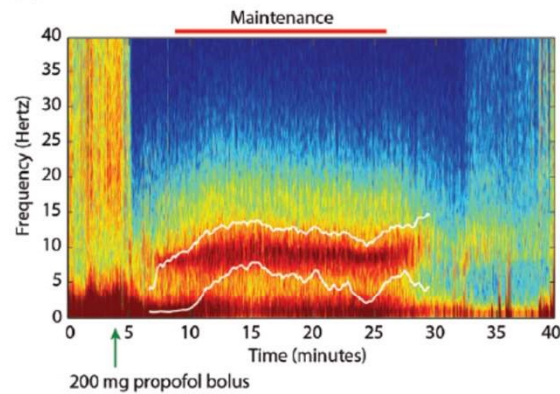
Correlation between ICON variation and NIRS at +5 minutes



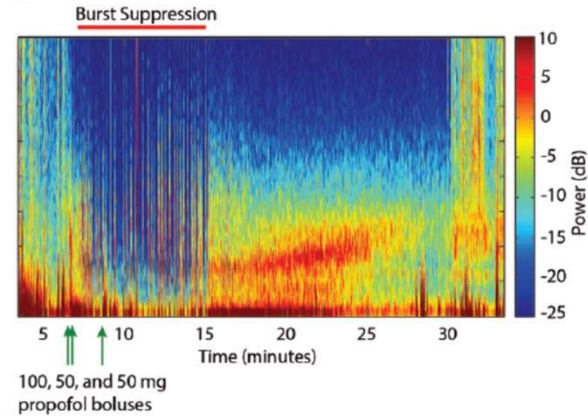


Analyse spectrale EEG

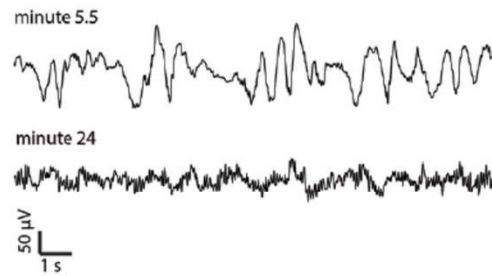
A Propofol-Induced Unconsciousness: Slow and Alpha Oscillations



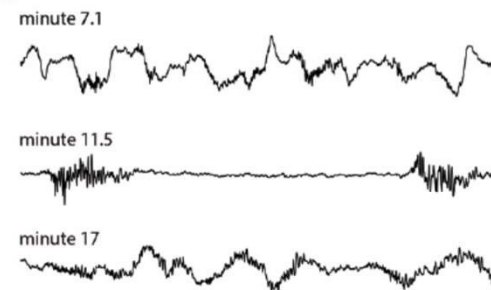
B Propofol-Induced Unconsciousness: Burst Suppression



C

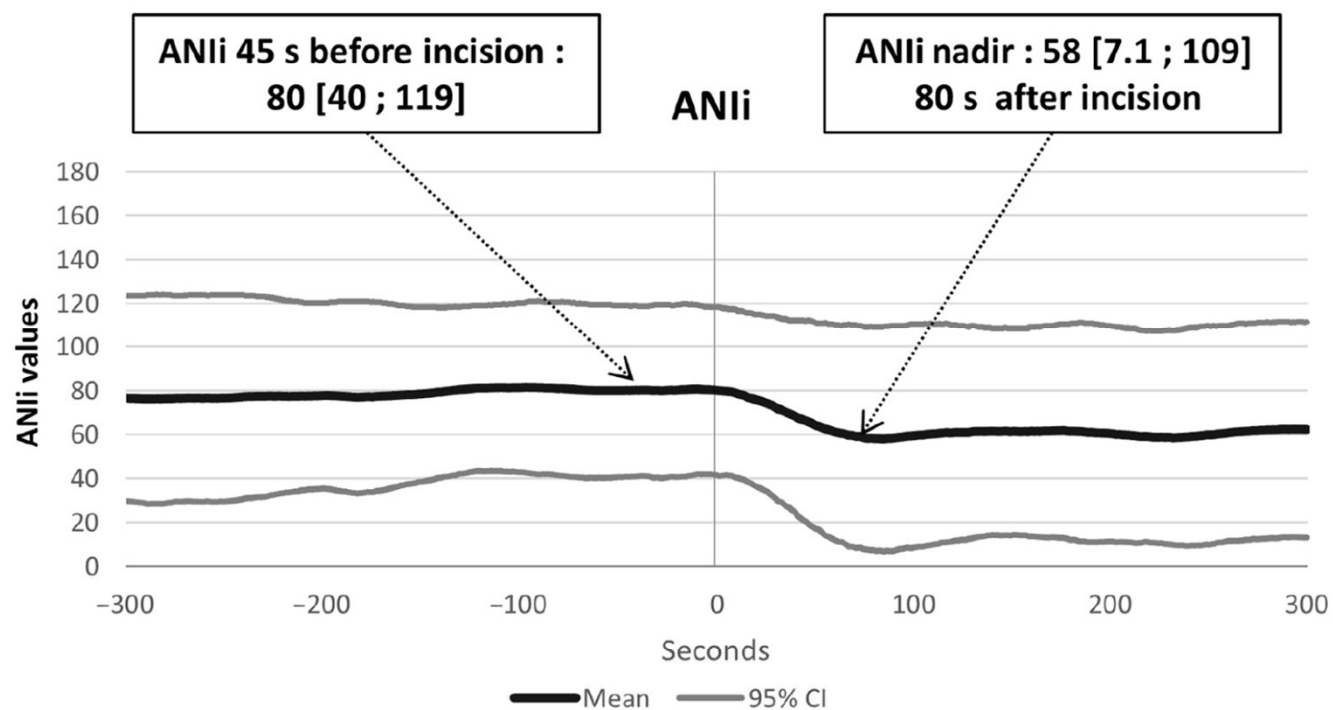


D





Monitoring de la douleur : ANI

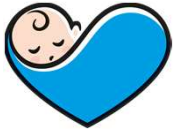


	HR	SBP	DBP	MBP
AUROC	0.511 [0.490 - 0.532]	0.596 [0.575 - 0.617]	0.575 [0.554 - 0.595]	0.585 [0.565 - 0.606]

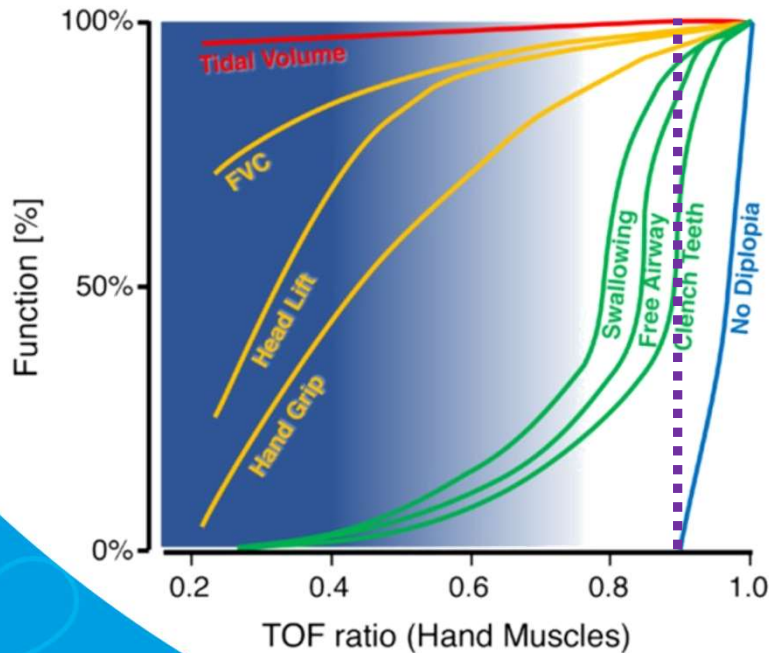


Que dois-je faire ?

Utiliser le monitoring en fonction des
risques à éviter/bénéfices à attendre



- **Monitoring systématique : PA, FC, EEG, SaO₂, CO₂TE et température**



T1/T4 TOF $\geq 0,9$



Glycémie

- Surveillance glycémique et de la cétonémie chez l'enfant
- Enfant : Diabète type I avec réserves quasi-nulles en insuline
= acidocétose diabétique très rapide
- Conduite à tenir
 - Renforcement du traitement insulinaire
 - Surveillance rapprochée de la glycémie et de la cétonémie

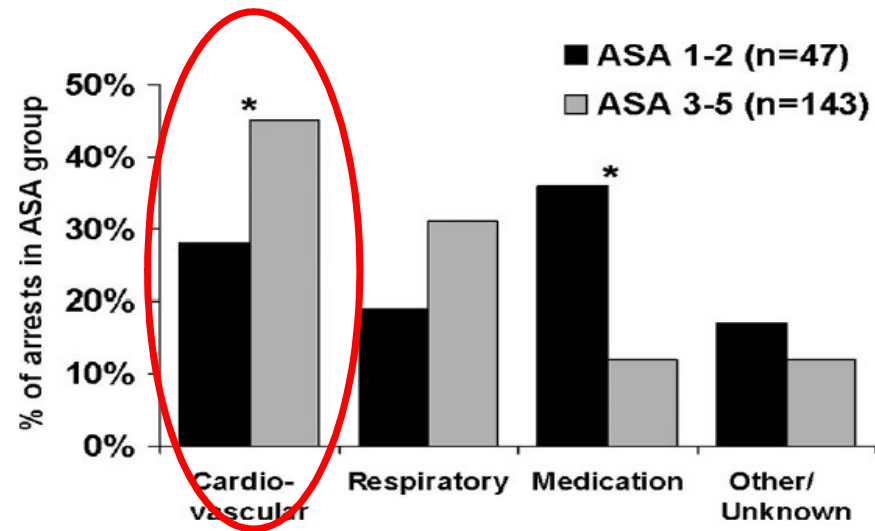


Monitorage hémodynamique

Cause	n = 193 No. (% of 193)
Cardiovascular	79 (41)
Hypovolemia associated with blood loss	23 (12)
Electrolyte imbalance	10 (5)
Hypovolemia (nonhemorrhage)	5 (3)
Air embolism	4 (2)
Other CV	11 (6)
Presumed CV unclear mechanism	26 (13)
Respiratory	53 (27)
Airway obstruction—laryngospasm	11 (6)
Airway obstruction—other	5 (3)
Inadequate ventilation or oxygenation	9 (5)
Inadvertent or premature extubation	7 (4)
Difficult intubation	4 (1)
Esophageal or endobronchial intubation	3 (2)
Bronchospasm	4 (2)
Pneumothorax	2 (1)
Aspiration	2 (1)
Other	1 (1)
Presumed respiratory, unclear mechanism	5 (3)
Medication	35 (18)
Halothane-induced CV depression	9 (5)
Sevoflurane-induced CV depression	6 (3)
Other single medication*	9 (5)
Medication combination	7 (3)
Allergic reaction	2 (1)
Intravascular injection of local	2 (1)
Equipment	9 (5)
Central catheter	5 (3)
Kinked or plugged ET tube	2 (1)
Peripheral IV catheter	1 (1)
Breathing circuit	1 (1)
Multiple events	3 (2)
Miscellaneous	2 (1)
Unknown	12 (6)



Incidence : 3 à 20 /10 000 anesthésies





	Age	ASA category	Procedure	Timing	Clinical signs	Perioperative severe adverse event	Plausible cause	Treatment	Outcome	Status at 30 days
Children with perioperative cardiac arrest (n=9)										
Case 1	8m	II	Trauma	Maintenance	..	Hypotension, hypoxaemia	Displacement endotracheal tube during endoscopic thoracic surgery, severe hypoxaemia, and hypotension	CCM, atropine, ephedrine, re-intubation	Uneventful	Discharged home
Case 2	4y 6m	II	ENT	PACU	..	Hypoxaemia	Pneumothorax under tension (closure tracheostomy)	CCM, epinephrine	Uneventful	Still in hospital
Case 3a	4y 3m	IV	Cardiac catheterism (eg, DORV, VSD, ASD, pulmonary stenosis)	Induction (ketamine)	..	Arrhythmia, hypotension	Low cardiac output at induction	CCM, epinephrine	Recovered; admitted to ICU for 24 hours	Death from cardiopathy
Case 3b	4y 3m	V	Cardiac surgery	Induction (etomidate and ketamine)	..	Arrhythmia, hypotension	Low cardiac output at induction from complex cardiopathy	CCM, OCM, defibrillation, epinephrine, calcium, bicarbonate	Bypass in urgent situation; admitted to ICU (for 19 days)	Death from cardiopathy
Case 4	14y 8m	II	Trauma	Maintenance	..	Hypoxaemia, haemodynamic instability, bradycardia	Trachea blocked by endobronchial blocker	CCM, atropine	Uneventful	Discharged home
Case 5	1m	II	Gastrointestinal surgery	Induction	..	Severe hypoxaemia (SpO ₂ <85% for >2 min), bradycardia, asystole	Difficult ventilation; no intubation	CCM, epinephrine	Haemodynamic instability; neurological controls normal	Discharged home
Case 6	5d	IV	Cardiac surgery	Maintenance	..	Haemodynamic instability	Norwood operation	CCM, defibrillation, extracorporeal membrane oxygenation	Multiple organ failure and death	Death
Case 7	10y 10m	V	Gastrointestinal surgery	Induction (rapid sequence induction with propofol-atracurium)	..	Bleeding, hypotension, transfusion	..	CCM, epinephrine, phenylephrine	Death from sepsis	Death
Case 8	2m	III	Gastroenterology endoscopy	Induction	..	Hypotension, severe hypoxaemia (SpO ₂ about 60%)	Cardiac dysfunction in a complex patient; low cardiac output	CCM, epinephrine, phenylephrine	Uneventful	Still in hospital
Case 9	29d; born at 36 weeks	IV	Thoracic	Maintenance	..	Hypotension, bradycardia	Under ACE inhibitors for coarctation	CCM, atropine	Uneventful	Discharged to acute centre

(Table 5 continues on next page)

Incidence 3 / 10 000



Mortalité 1,3 / 10 000



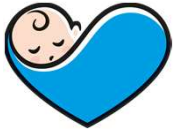
Variable	Deaths/Total	Crude Rate per 100,000 Cases	Unadjusted OR (95% CI), n = 2,866,141	Adjusted OR* (95% CI), n = 2,104,998
Patient age group (yr)				
<1	42/47,388	89	5.08 (3.62–7.12)	4.09 (2.38–7.05)
1–18	34/244,609	14	0.80 (0.55–1.15)	0.89 (0.48–1.68)
19–49	169/968,502	17	Ref	Ref
50–64	233/768,154	30	1.74 (1.43–2.12)	1.25 (0.94–1.65)
65–79	296/613,728	48	2.76 (2.29–3.34)	1.84 (1.40–2.43)
≥80	144/191,347	75	4.32 (3.45–5.39)	2.23 (1.62–3.08)
Patient sex				
Female	418/1,643,054	25	Ref	Ref
Male	526/1,196,414	44	1.73 (1.52–1.97)	0.93 (0.78–1.12)
ASA physical status				
1 or 2	116/1,740,144	7	Ref	Ref
3	150/799,232	19	2.82 (2.21–3.59)	2.15 (1.61–2.87)
4	367/181,182	203	30.4 (24.7–37.5)	14.2 (10.7–18.9)
5	271/4,646	5,833	929 (743–1160)	204 (144–289)
Procedure urgency				
Nonemergent	737/2,647,035	28	Ref	Ref
Emergent	177/82,234	215	7.74 (6.56–9.12)	2.70 (2.07–3.52)
Case start time				
7:00 AM–3:59 PM	364/2,075,621	18	Ref	Ref
4:00 PM–5:59 PM	59/117,055	50	2.88 (2.18–3.79)	1.64 (1.22–2.21)
6:00 PM–10:59 PM	74/85,989	86	4.91 (3.82–6.31)	1.69 (1.26–2.28)
11:00 PM–6:59 AM	62/70,606	88	5.01 (3.82–6.56)	1.97 (1.43–2.70)
Surgery type				
Extremity	102/552,902	18	Ref	Ref
Head/spine	62/329,116	19	1.02 (0.74–1.40)	0.79 (0.5–1.18)
Thorax/neck	201/373,438	54	2.92 (2.30–3.70)	1.29 (0.96–1.74)
Abdomen/pelvis	382/966,942	40	2.14 (1.72–2.66)	1.58 (1.20–2.08)
Obstetric	6/162,443	4	0.20 (0.09–0.46)	0.51 (0.20–1.32)
Radiological	38/74,520	51	2.77 (1.90–4.01)	0.99 (0.62–1.58)
Eye	3/118,921	3	0.14 (0.04–0.43)	0.22 (0.07–0.72)



NECTARINE

6000 infants < 60 wks postconceptional age

Factor	French cohort (N = 926)	European Cohort (N = 5609)
Follow up at day 30	835 (90.2 %)	5510 (93.3 %)
Mortality at day 30	15 (1.8 %)	105 (1.9 %)
Location at day 30		
- Home	648 (77.6 %)	
- Hospital	69 (8.3 %)	
- Other hospital	46 (5.5 %)	
- ICU	57 (6.8 %)	
Complications at day 30	117 (14.4 %)	850 (16.3 %)
- Neurological	14 (1.7 %)	146 (2.6 %)
- Surgical	14 (1.7 %)	329 (6 %)
- Respiratory	54 (6.6 %)	457 (8.3 %)
- Cardio-vascular	32 (3.9 %)	315 (5.7 %)
- Renal complications	10 (1.3 %)	98 (1.8 %)
- Liver complications	7 (0.9 %)	51 (0.9 %)
Overall mortality at day 30 and 90	19 (2 %)	136 (2.4 %)



- Facteurs liées au terrain : âge < 1 an
- Facteur lié aux comorbidités : ASA 3 à 5,
- Facteurs liées à la chirurgie : voies aériennes, cardiaque ou chirurgie à potentiel hémorragique.
- Facteurs liées aux conditions de réalisation : chirurgie urgente, réalisation sur des périodes de garde.



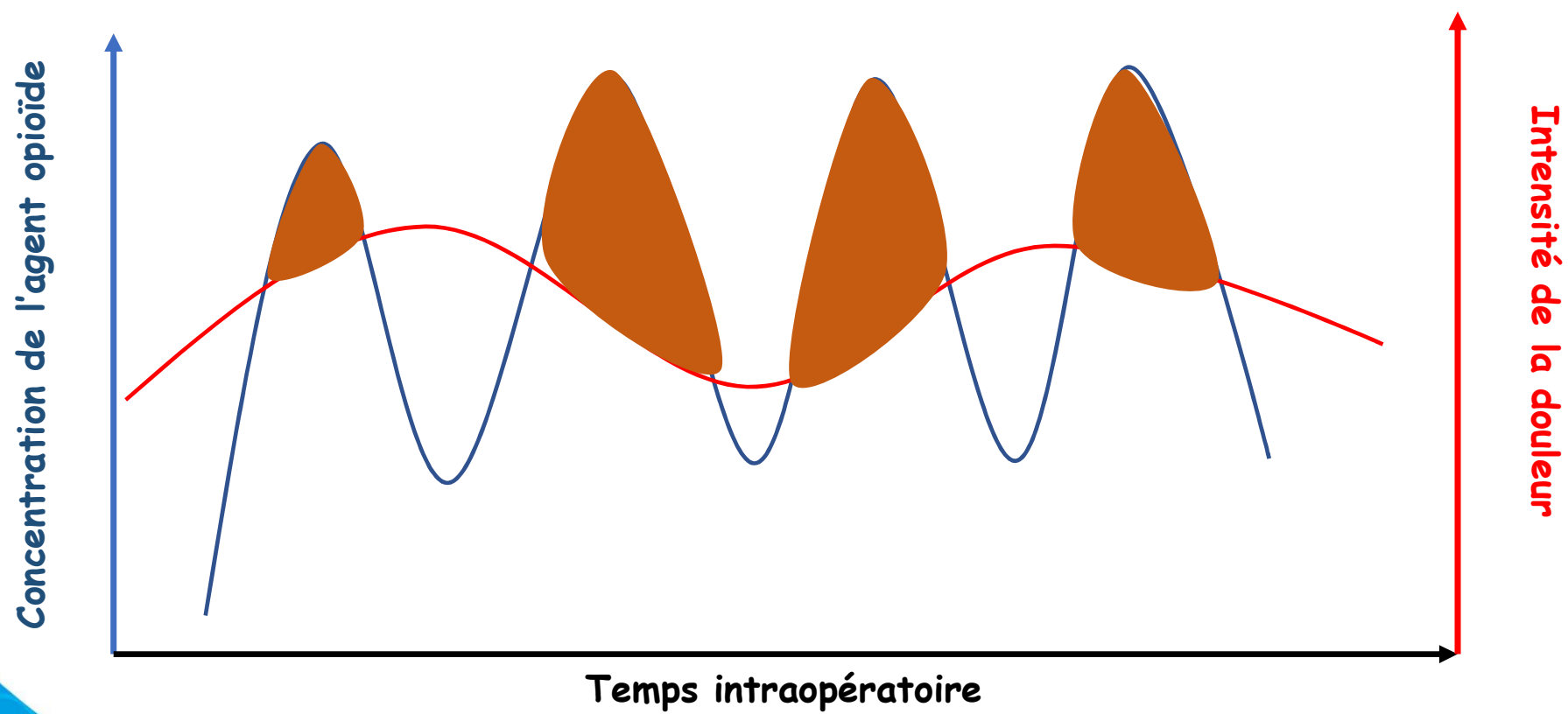
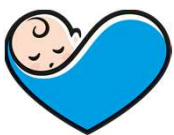
Monitoring de l'EEG

- Pourquoi pas dire tout le monde ?
- En situations de risques de mémorisation :
 - Classiquement nécessité d'ajuster l'anesthésie à des conditions hémodynamiques difficiles mais...
 - Facteurs de risques ne retrouvent pas facilement cet élément (0,8 %)
- Cas particulier de co-administration de deux hypnotiques :
Dexmedetomidine & sévoflurane/propofol.



Monitoring de la nociception

- Femmes >> hommes
- **Cicatrice (étendue de la chirurgie)**
- Douleur préopératoire
- **Consommation de morphine périopératoire**
- Douleur neuropathique postopératoire précoce
- Facteurs psychologiques : terrain anxieux





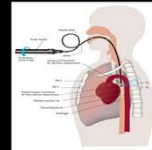
Que m'est-il permis d'espérer ?



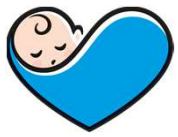
« La déception fait partie de notre humanité. Il faut donc l'accepter aussi : cesse d'espérer n'être jamais déçu. »



Pas de saturation pas de désaturation

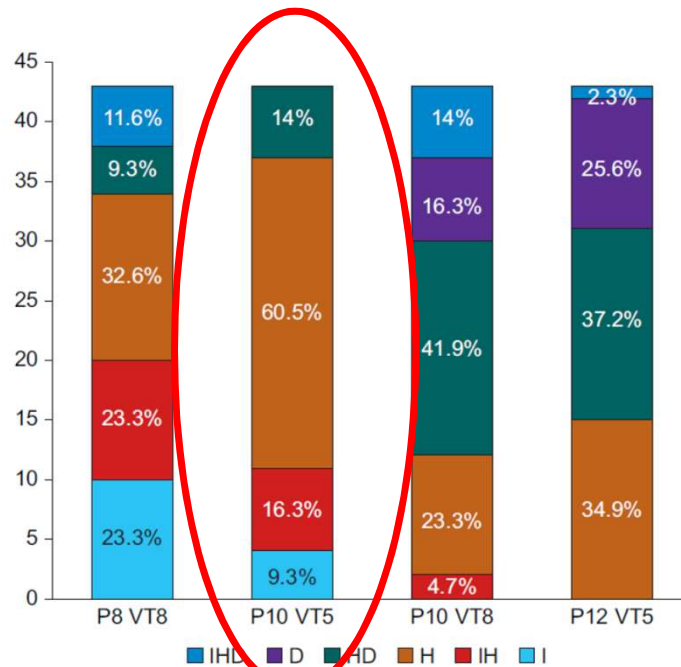


Pas de débit cardiaque, pas de baisse du débit cardiaque



Que m'est-il permis d'espérer ?

- Que le pi
- v
- N
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sur

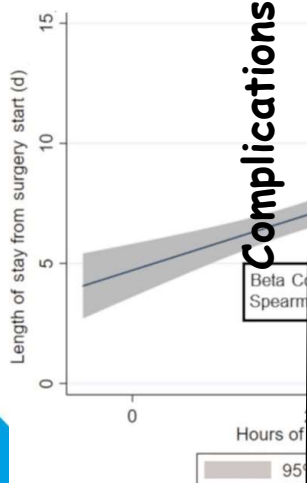
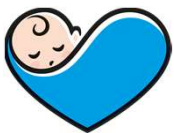
Lung ultrasound
Consolidation
Anterior
Lateral
Posterior
B-lines score
Anterior
Lateral
Posterior
Postoperative p
Respiratory
Pleural effu
Atelectasis
Pneumothc

2

0.50					
Technology		Measurements derived		Sample manufacturer(s) or brand(s)	
Transpulmonary indicator dilution		Cardiac output		LiDCO and PiCCO®	
Arterial waveform-derived		Stroke volume variation and cardiac output		FloTrac™, LiDCO and PiCCO®	
Oesophageal Doppler		Flow corrected time and stroke volume		CardioQ™	
Echocardiography		Cardiac output, stroke volume and contractility assessment		Philips® and Sonosite™	
Partial CO ₂ rebreathing		Cardiac output		NICO®	
Bioreactance		Cardiac output		NICOM®	
Illustrative comparative risks (95% CI)					
Outcomes	Assumed risk (standard care group)	Corresponding risk reduction in GDT group (95% CI)	Relative effect (95% CI)	Number of subjects (number of studies)	Quality of the evidence (GRADE)
Mortality	52 per 1000 patients	18 (7 to 26) events avoided per 1000 patients	0.66 (0.50 to 0.87)	5550 (52)	⊕⊕ low ^a
Arrhythmia	109 per 1000 patients	30 (10 to 47) events avoided per 1000 patients	0.70 (0.55 to 0.91)	3269 (33)	⊕⊕ low ^a
CHF	28 per 1000 patients	Not significantly different	0.61 (0.33 to 1.12)	2125 (17)	⊕⊕ low ^a
Pneumonia	93 per 1000 patients	27 (7 to 43) events avoided per 1000 patients	0.69 (0.52 to 0.92)	2776 (29)	⊕⊕ low ^a
Wound infection	111 per 1000 patients	55 (39 to 67) events avoided per 1000 patients	0.48 (0.37 to 0.63)	3593 (32)	⊕⊕ low ^a
AKI	141 per 1000 patients	35 (11 to 55) events avoided per 1000 patients	0.73 (0.58 to 0.92)	4310 (37)	⊕⊕ low ^a
Hospital LoS	The mean hospital LoS ranged across control groups from 1.2 to 29 days	The mean hospital LoS was 0.90 (0.48 to 1.32) days shorter in the GDT group		8797 (62)	⊕ very low ^{a,b}
ventilation					

ventilation

Futier E et al. NEJM 2013.
Chong MA et al, Eur J Anaesthesiol 2018.
Lee JH et al. Brit J Anaesth 2019
Lee JH et al. Brit J Anaesth 2021



Complications

StO_2

Q

Volémie

Univariable analyses

Multivariable analysis

confidence

3]

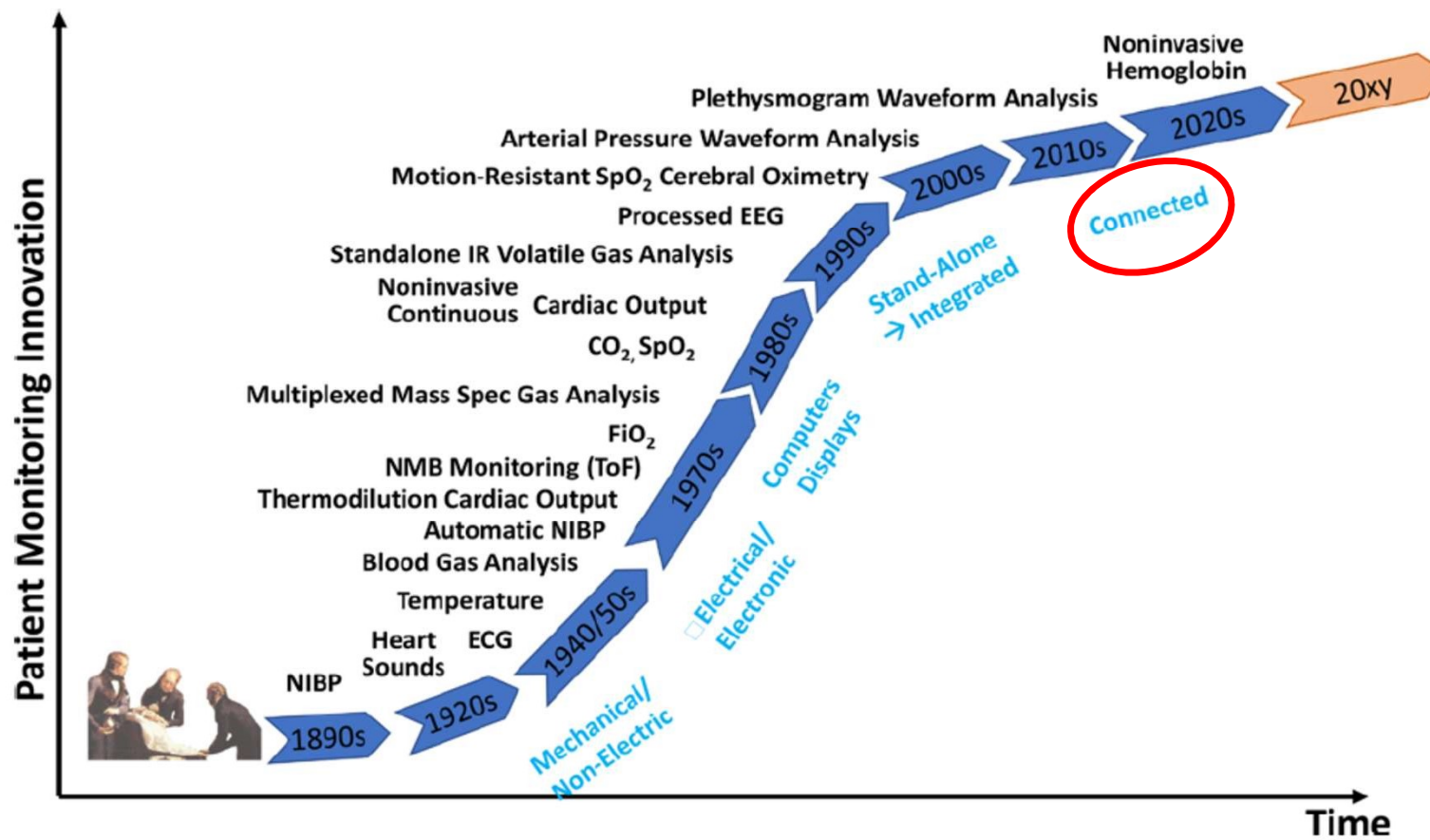
operative
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ratio [95% confidence
interval]

1.6; 1.06]

[1.031;1.136]

Sanford EI et al. *Pediatr Anesth* 2018
Julien-Marsollier F et al. *Pediatr Anesth* 2022
Julien-Marsollier F et al. *Pediatr Anesth* 2023





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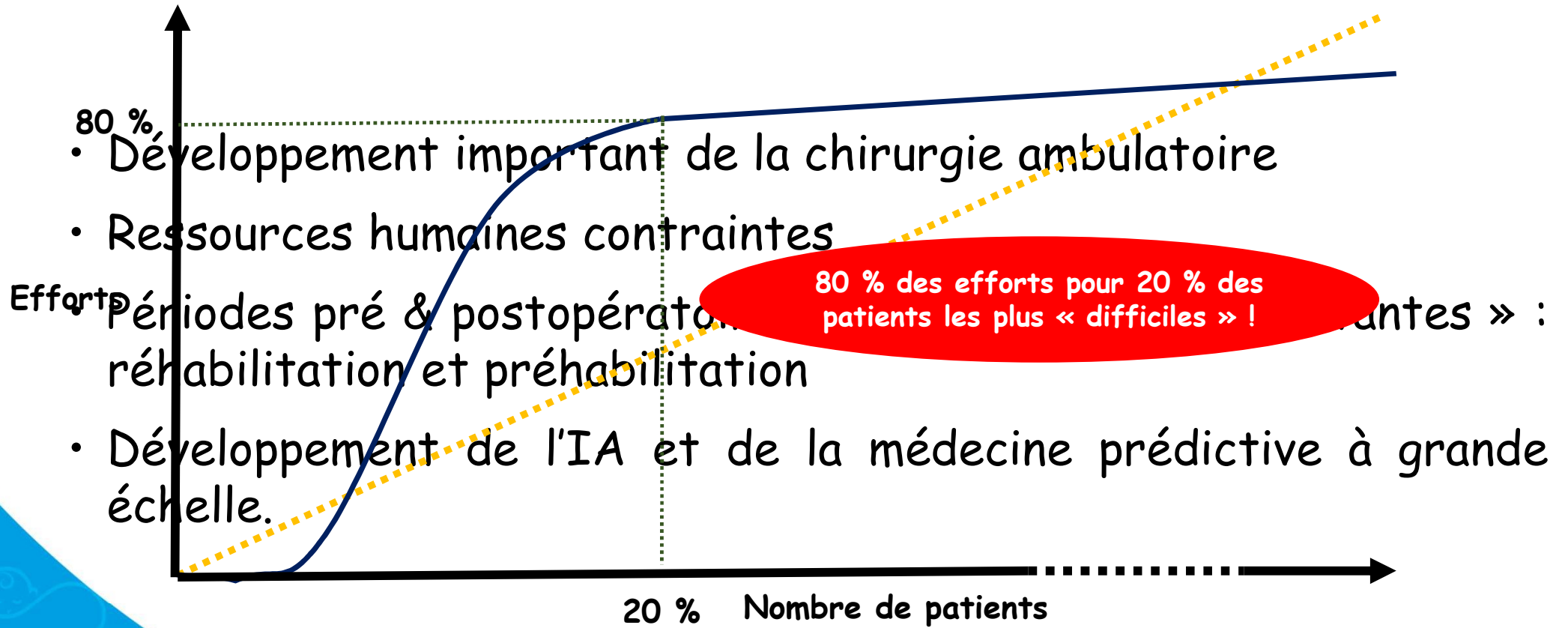
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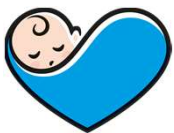
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A follow-up of pain reported by children undergoing outpatient surgery using a smartphone application: AlgoDARPEF multicenter descriptive prospective study

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L'hôpital du futur



Multiple Home Health
Kit Devices



Data Available to
Care Providers