

Ventilation chez l'enfant :
la prévention et le traitement des atélectasies, la ventilation protectrice, la meilleure FIO_2, la PEP

Florent BAUDIN, MCU-PH
Anesthésie et réanimation pédiatrique
Hôpital Femme Mère Enfant, Hospices civils de Lyon

HCL HOSPICES CIVILS DE LYON
UNIVERSITÉ DE LYON
Université Claude Bernard Lyon 1



Déclarations d'intérêt:

- Maquet, Getinge (passé)
- Fisher & Paykel (en cours)

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25 & 26 MARS 2022
MONTPELLIER
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BJA

British Journal of Anaesthesia, 123 (6): 898–913 (2019)

doi: 10.1016/j.bja.2019.08.017
Advance Access Publication Date: 3 October 2019
Special Article

RESPIRATION AND THE AIRWAY

Lung-protective ventilation for the surgical patient: international expert panel-based consensus recommendations

Christopher C. Young[1,2,*], Erica M. Harris[2], Charles Vacchiano[1,3], Stephan Bodnar[3], Brooks Bukowy[3], R. Ryland D. Elliott[2], Jaclyn Migliarese[3], Chad Ragains[2], Brittany Trethewey[3], Amanda Woodward[4], Marcelo Gama de Abreu[5], Martin Girard[6], Emmanuel Futier[7], Jan P. Mulier[8], Paolo Pelosi[9,10] and Juraj Sprung[11]

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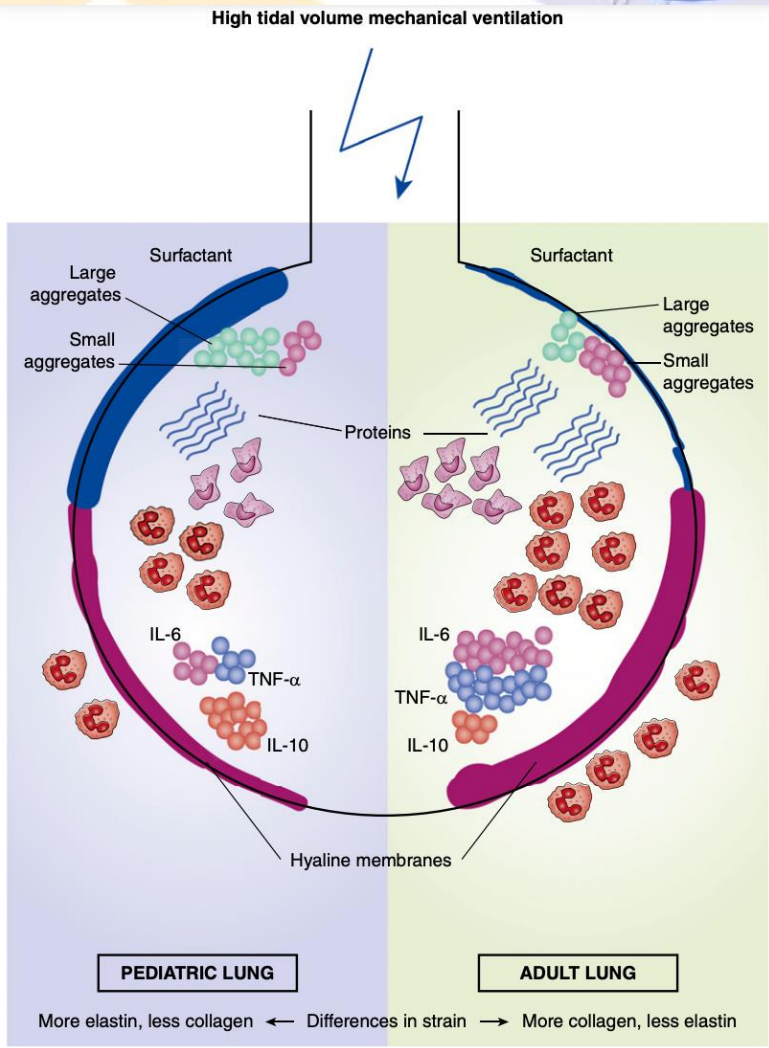
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CRITICAL CARE PERSPECTIVE

Ventilator-induced Lung Injury
Similarity and Differences between Children and Adults

Martin C. J. Kneyber[1,2,3], Haibo Zhang[1,4,5,6], and Arthur S. Slutsky[1,5]

[1]Keenan Research Centre for Biomedical Science of St. Michael's Hospital, Toronto, Ontario, Canada; [2]Department of Paediatrics, Division of Paediatric Intensive Care, Beatrix Children's Hospital, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands; [3]Critical Care, Anesthesiology, Peri-Operative Medicine & Emergency Medicine, University of Groningen, Groningen, The Netherlands; and [4]Department of Anaesthesia, [5]Interdepartmental Division of Critical Care Medicine, and [6]Department of Physiology, University of Toronto, Toronto, Ontario, Canada



PCCM Perspectives

Acute Lung Injury in Children—Kids Really Aren't Just "Little Adults"

Neal J. Thomas, MD, MSc[1]; Philippe Jouvet, MD, PhD[2]; Douglas Willson, MD[3]



Quel volume courant ?

Question	Statement/recommendation	Consensus (%)	Quality of evidence	Strength of recommendation
1.2	Use a low-tidal-volume protective-ventilation strategy (6–8 ml kg^{-1} PBW). ZEEP is not recommended. Appropriate PEEP and recruitment manoeuvres may improve intraoperative respiratory function and prevent PPCs.	86	☒☒☒☐	Strong

Volume courant = 6 à 8ml/kg de poids idéal

En pédiatrie

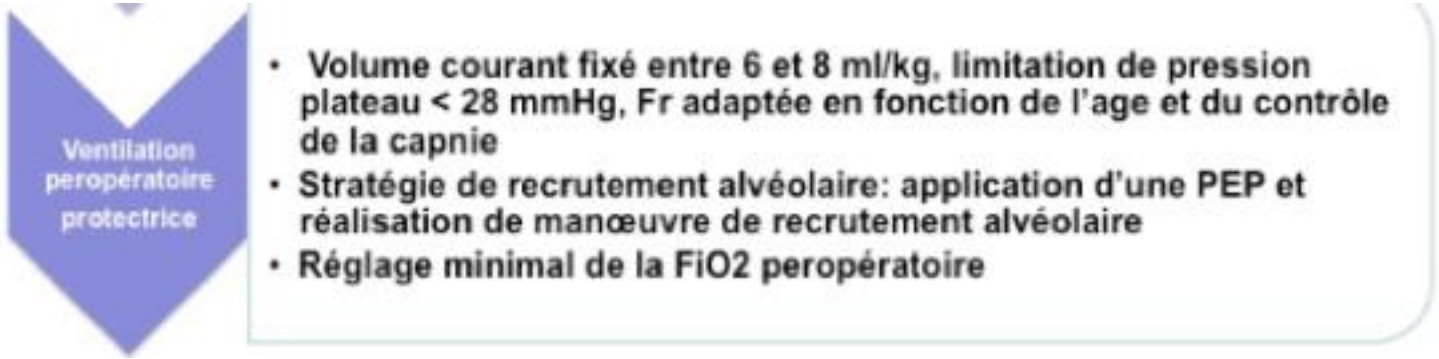




The recommended tidal volume is typically 6 to 7 mL/kg of predicted body weight, and PEEP is typically used to reduce the likelihood of atelectasis.

ANESTHESIA & ANALGESIA

Feldman et al. 2015



Duracher et al. Congrès SFAR 2017

The set tidal volume should be within the range of 6 - 10 mL/kg, but the optimal tidal volume depends upon the disease severity of the lung.

Kneyber et al. 2015



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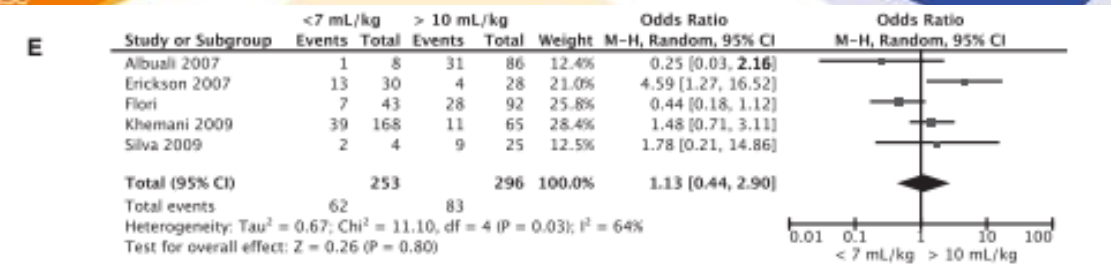
Association des Anesthésistes Réanimateurs Pédiatriques d'Expression Française

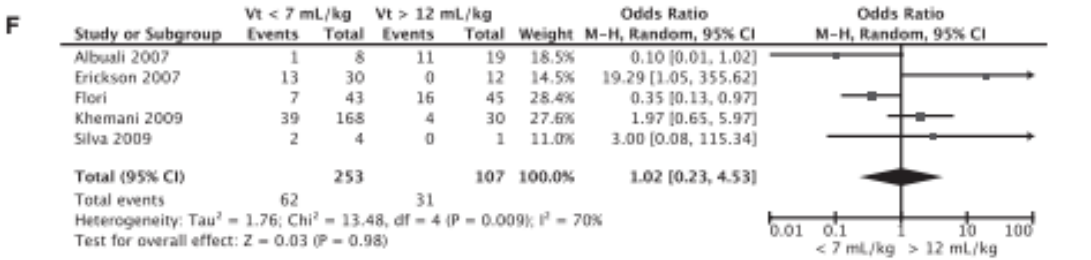
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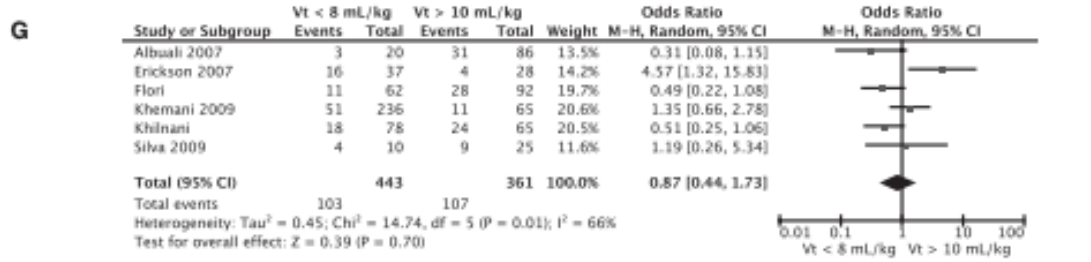
Tidal Volume and Mortality in Mechanically Ventilated Children: A Systematic Review and Meta-Analysis of Observational Studies*

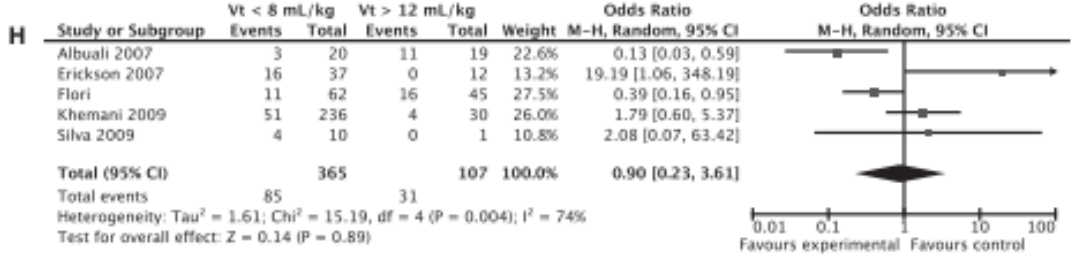
Pauline de Jager, MD[1]; Johannes G. M. Burgerhof, MSc[2]; Marc van Heerde, MD, PhD[3]; Marcel J. I. J. Albers, MD, PhD[4]; Dick G. Markhorst, MD, PhD[3]; Martin C. J. Kneyber, MD, PhD[1,3,5]

De Jager et a. Critical Care 2014









CONFERENCE REPORTS AND EXPERT PANEL

Recommendations for mechanical ventilation of critically ill children from the Paediatric Mechanical Ventilation Consensus Conference (PEMVECC)

Interestingly, some observational studies reported better outcomes for children who were ventilated with Vt > 5–8 ml/kg and only one identified lower mortality associated with Vt ~8 mL/kg actual bodyweight compared with ~10 mL/ kg

En pratique …

Gestion de l'espace mort en pédiatrie

Filtre +++







	Ref. 1441000	Ref. 1831000	Ref. 1641000
Volume compressible	11 ml	26 ml	34 ml

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British Journal of Anaesthesia **110** (6): 1045–51 (2013)
Advance Access publication 4 February 2013 · doi:10.1093/bja/aes594

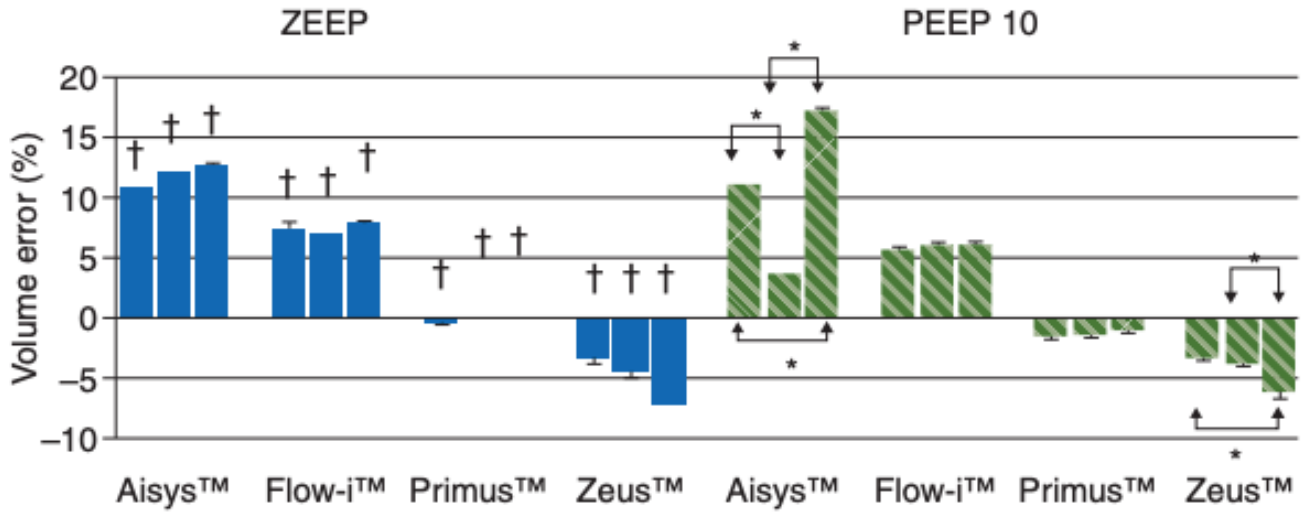
BJA

RESPIRATION AND THE AIRWAY

Delivery of tidal volume from four anaesthesia ventilators during volume-controlled ventilation: a bench study†

G. Wallon[1], A. Bonnet[1] and C. Guérin[2,3]*

[1] Service d'Anesthésie-Réanimation and [2] Service de Réanimation Médicale, Hôpital de la Croix-Rousse, Hospices Civils de Lyon et Université de Lyon, 103 Grande Rue de la Croix Rousse, Lyon 69004, France
[3] Créatis, INSERM 1004 CNRS 5220, Lyon, France
* Corresponding author. E-mail: claude.guerin@chu-lyon.fr



- Test de fuite … ou de compensation de la compliance

Accepted: 30 March 2017
DOI: 10.1111/pan.13164

RESEARCH REPORT

WILEY Pediatric Anesthesia

Breathing circuit compliance and accuracy of displayed tidal volume during pressure-controlled ventilation of infants: A quality improvement project

Todd A. Glenski | Carrie Diehl | Rachel G. Clopton | Robert H. Friesen

PCV mode
PI: 18/4,
RR 24 (infant) or 15 (adult)
I:E ratio 1:2.

tubing not expanded vs expanded

TABLE 1 Changes in circuit compliance and displayed tidal volume measurements in infant and adult test lungs during pressure-controlled ventilation at 18/4 cm H_2O when the anesthesia machine preuse self-test was performed before and after circuit tubing expansion

Machine	Drager Apollo (n=4)	GE Avance S5 (n=10)	GE Aisys (n=4)	All Combined (n=18)
Compliance[a] (mL/cm H_2O)	0.43±0.05	0.45±0.07	0.47±0.07	0.45±0.07
Compliance[b] (mL/cm H_2O)	0.97±0.05	0.92±0.10	0.95±0.07	0.94±0.09
Infant TV[c] (mL)	14±5	15±3	19±6	15±5
Infant TV[d] (mL)	8±2	8±3	12±5	9±4
Adult TV[c] (mL)	246±11	234±92	284±14	245±74
Adult TV[d] (mL)	249±18	227±89	278±15	241±72

Sans extension

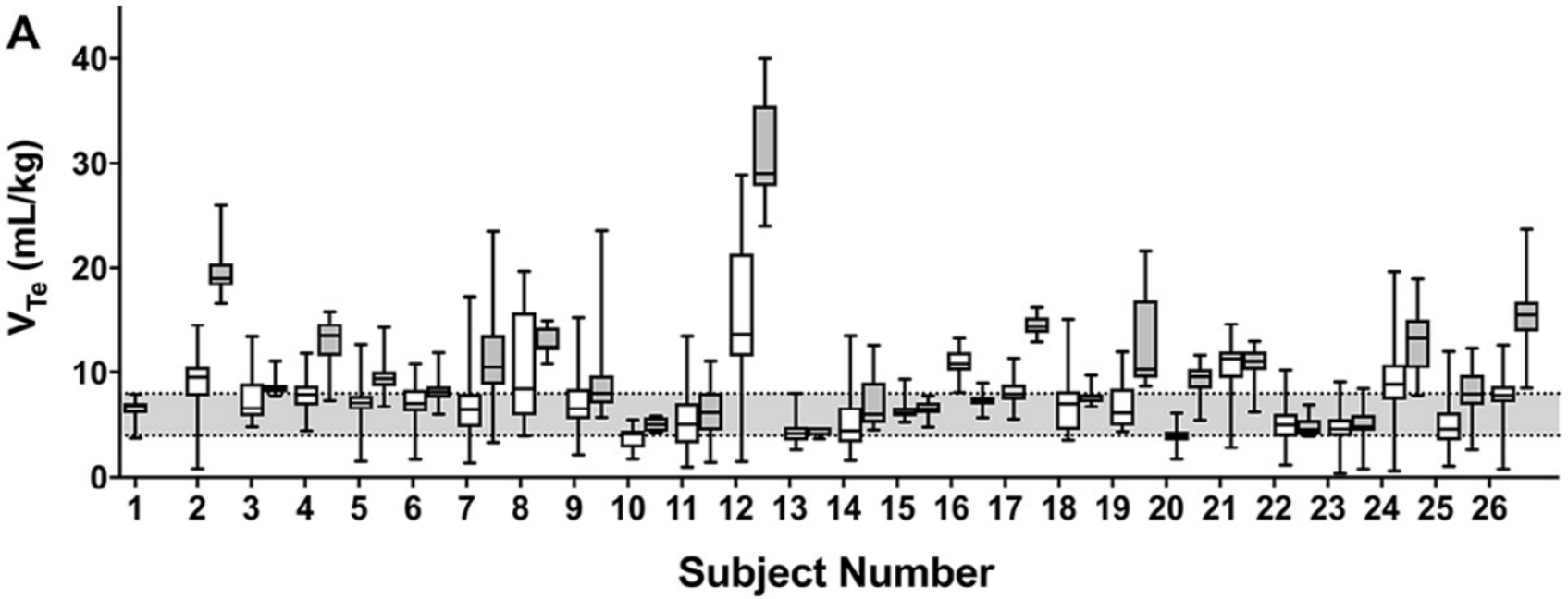
Sans extension

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Tidal Volume Delivery during the Anesthetic Management of Neonates Is Variable

Thanaa Abouzeid, BBiomed[1,2], Elizabeth J. Perkins, RN[1], Prue M. Pereira-Fantini, PhD[1], Anushi Rajapaksa, PhD[1,2], Asha Suka, BSci[1,2], and David G. Tingay, PhD[1,2,3]

Characteristics	Values
GA at birth (completed wk), mean (SD)	35.7 (4.8)
Corrected GA (completed wk), mean (SD)	39.9 (3.3)
Birth weight, g, mean (SD)	2634 (1041)
Weight, g, mean (SD)	3167 (736)



Une question?

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Chahat petite fille de 17 Kg
Quelle volume courant ?

A. 170 ml
B. 130 ml (~ 8 ml/Kg)
C. 70 ml (~ 4 ml/Kg)
D. Euh .. C'est un piège?



8 mois … 17 Kg



[Original Research **Critical Care**]

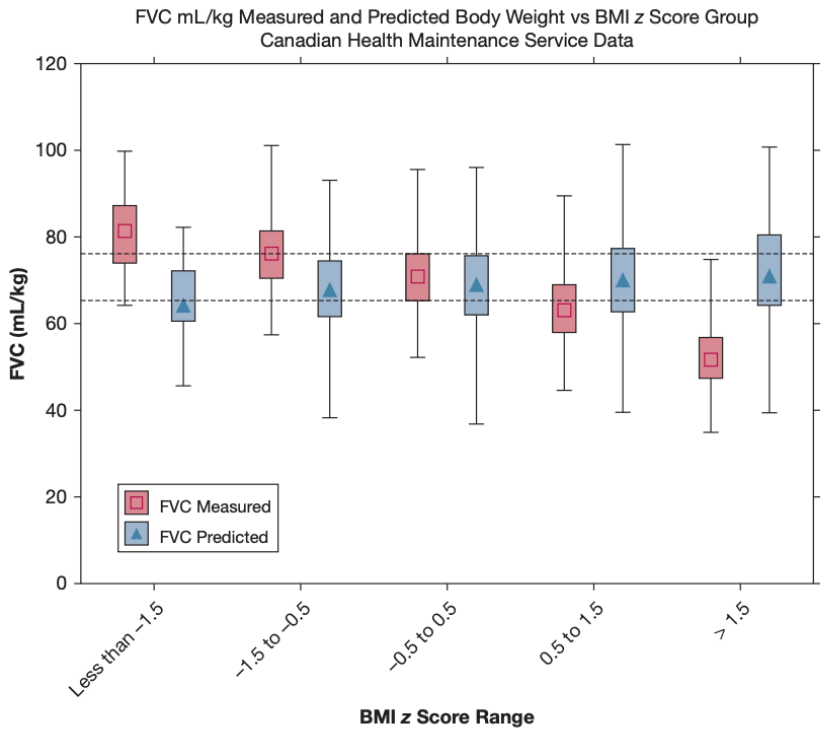
CHEST

Does Size Matter When Calculating the "Correct" Tidal Volume for Pediatric Mechanical Ventilation?

A Hypothesis Based on FVC

Gina J. Kim, MD; Christopher J. L. Newth, MD; Robinder G. Khemani, MD; Suzy L. Wong, PhD; Allan L. Coates, MD; and Patrick A. Ross, MD

Check for updates



Obese children have lung volumes reflecting their predicted body weight from height.
Children with low or normal BMI have lung volumes reflecting measured body weight.

Attention au peri-opératoire

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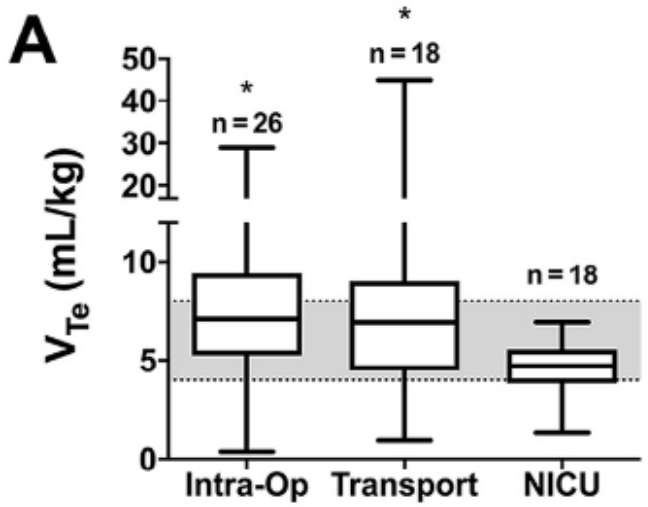
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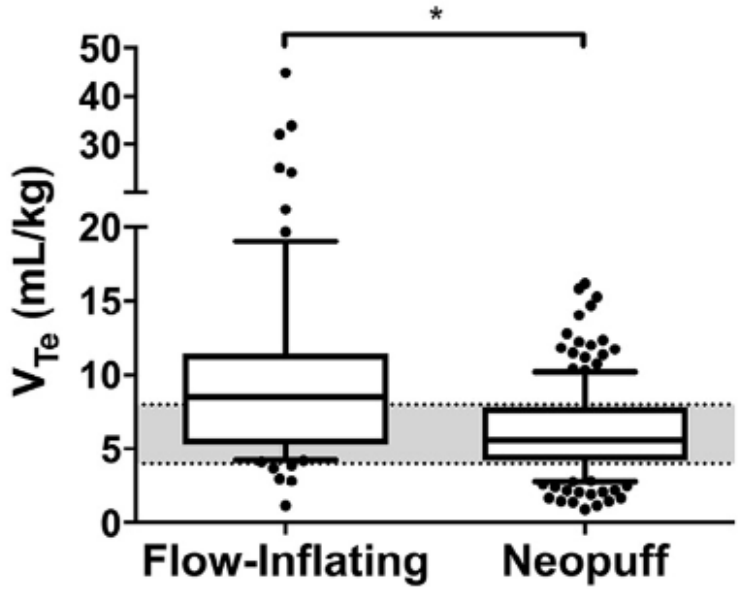
THE JOURNAL OF PEDIATRICS • www.jpeds.com

ORIGINAL ARTICLES

Tidal Volume Delivery during the Anesthetic Management of Neonates Is Variable

Thanaa Abouzeid, BBiomed[1,2], Elizabeth J. Perkins, RN[1], Prue M. Pereira-Fantini, PhD[1], Anushi Rajapaksa, PhD[1,2], Asha Suka, BSci[1,2], and David G. Tingay, PhD[1,2,3]





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Les atélectasies … gestion et prévention !

The New England Journal of Medicine

Copyright, 1963, by the Massachusetts Medical Society

Volume 269 NOVEMBER 7, 1963 Number 19

IMPAIRED OXYGENATION IN SURGICAL PATIENTS DURING GENERAL ANESTHESIA WITH CONTROLLED VENTILATION*

A Concept of Atelectasis

H. H. BENDIXEN, M.D.,† J. HEDLEY-WHYTE, M.B., B.CHIR.,‡ AND M. B. LAVER, M.D.§

BOSTON

Prévalence ?



Très variable selon les études

Très élevé avec l'imagerie 68 à 100% si on ne fait rien

Pediatric Anesthesia 2007 **17**: 121–125 doi:10.1111/j.1460-9592.2006.02045.x

Atelectasis in children undergoing either propofol infusion or positive pressure ventilation anesthesia for magnetic resonance imaging (82% vs 94%)

EJA *Eur J Anaesthesiol* 2017; **34**:1–8

ORIGINAL ARTICLE

Lung recruitment prevents collapse during laparoscopy in children

A randomised controlled trial (19% vs 80%)

Journal of *Clinical Medicine* MDPI

Article

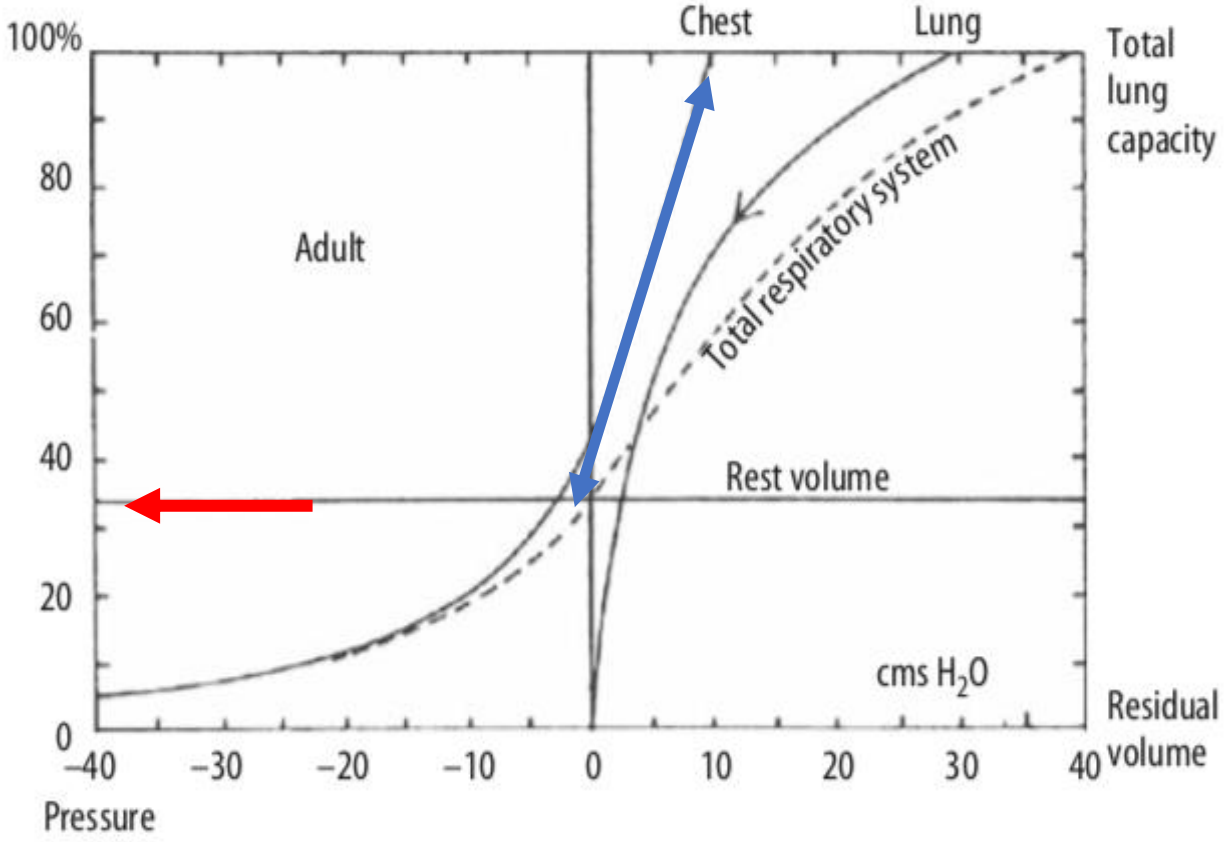
Factors Associated with Occurrence of Atelectasis during Sedation for Imaging in Pediatric Patients: A Retrospective Single Center Cohort Study (17% vs 45%)

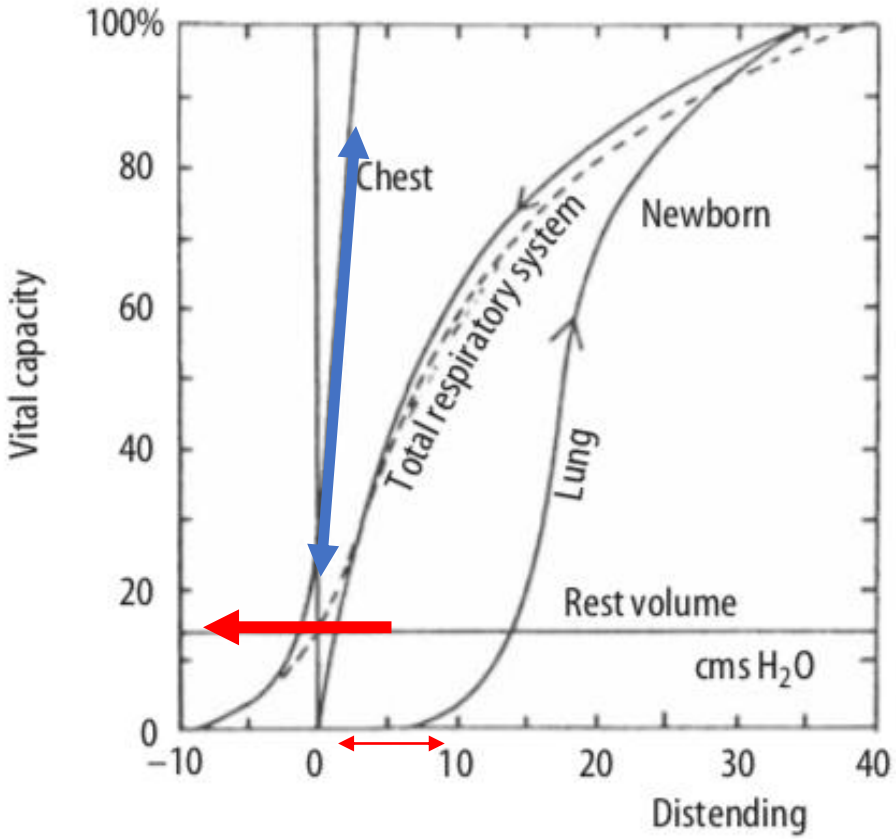
Pyeong Hwa Kim [1,†], Yong-Seok Park [2,†], Hee-Mang Yoon [1], Ah Young Jung [1], Eun-Young Joo [2], In-Cheol Choi [2] and Myung-Hee Song [2,*]

Les facteurs de risques?

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1. La pédiatrie





Les facteurs de risques?



1. La pédiatrie
2. L'anesthésie

Pediatric Anesthesia 2007 **17**: 121–125 doi:10.1111/j.1460-9592.2006.02045.x

Atelectasis in children undergoing either propofol infusion or positive pressure ventilation anesthesia for magnetic resonance imaging

(82% vs 94%)
VS – IOT/VPC

Journal of *Clinical Medicine* MDPI

Article

Factors Associated with Occurrence of Atelectasis during Sedation for Imaging in Pediatric Patients: A Retrospective Single Center Cohort Study

Pyeong Hwa Kim [1,†], Yong-Seok Park [2,†], Hee-Mang Yoon [1], Ah Young Jung [1], Eun-Young Joo [2], In-Cheol Choi [2] and Myung-Hee Song [2,*]

Table 5. Logistic regression analysis of factors associated with the occurrence of atelectasis.

Parameters	Univariable Analysis			Multivariable Analysis		
	Unadjusted OR	95% CI	*p*-Value	Adjusted OR	95% CI	*p*-Value
Age (months)	1.008	0.997–1.019	0.157			
Sex						
Female	Reference category			Reference category		
Male	0.797	0.334–1.888	0.606			
Sedative type						
Propofol	Reference category			Reference category		
Dexmedetomidine	0.255	0.085–0.677	0.009	0.828	0.204–3.350	0.791

Les facteurs de risques?



1. **La pédiatrie**
2. **L'anesthésie**
3. **La FiO_2 ++++**

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Propofol		Reference category			Reference category	
Dexmedetomidine	0.255	0.085–0.677	0.009	0.828	0.204–3.350	0.791
Supplemental oxygen administration	5.912	2.304–15.173	<0.001	4.838	1.478–15.831	0.009
Induction time (min)	0.931	0.856–1.006	0.072	0.970	0.891–1.055	0.473
Scan time (min)	1.018	0.980–1.058	0.361			
Use of adjuvant agents	0.692	0.252–1.899	0.474			

OR = odds ratio; CI = confidence interval. Variables with $p < 0.1$ were entered into the multivariable analysis.

Les facteurs de risques?

1. **La pédiatrie**
2. **L'anesthésie**
3. **La FiO_2 ++++**



Received: 8 May 2021 | Revised: 10 September 2021 | Accepted: 18 September 2021
DOI: 10.1111/pan.14304

RESEARCH REPORT

Pediatric Anesthesia WILEY

The effect of oxygen concentration on atelectasis formation during induction of general anesthesia in children: A prospective randomized controlled trial

Hyun Il Kim[1] | Ji Young Min[2] | Jeong-Rim Lee[1] | Choi Kwan Woong[3] | Matthew R. Cho[3] | Hyo-Jin Byon[1]

	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

Note: Data are presented as the medians (interquartile range).

*$p < .05$ comparing the three groups by the number of atelectatic lung regions 15 min after oxygenation (Kruskal-Wallis test).

TABLE 2 The number of atelectatic lung regions in children given 100%, 80%, or 60% oxygen during anesthesia induction

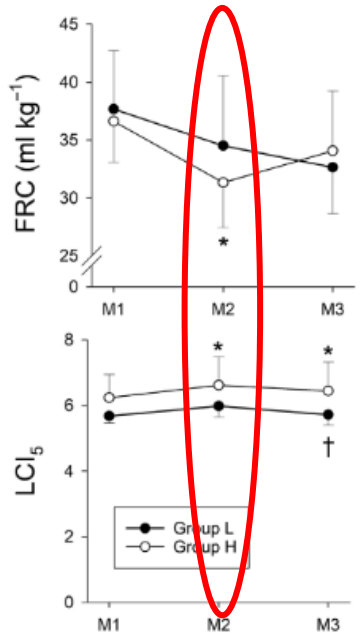
TABLE 3 Comparison of the number of atelectatic lung regions after anesthetic induction between groups (Dunn procedure)

Groups compared	*p* value
60% vs. 80%	.4422
60% vs. 100%	.0151[a]
80% vs. 100%	.0744

[a]*p* value under Bonferroni-adjusted alpha level of 0.0167 (0.05/3) was considered statistically significant (Dunn procedure).

Les facteurs de risques?

1. **La pédiatrie**
2. **L'anesthésie**
3. **La FiO_2 ++++**



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CLINICAL INVESTIGATION

High inspired oxygen fraction impairs lung volume and ventilation heterogeneity in healthy children: a double-blind randomised controlled trial

Béatrice de la Grandville[1,2,3], Ferenc Petak[4], Gergely Albu[2,3], Sam Bayat[2,3], Isabelle Pichon[2,3] and Walid Habre[2,3,*]

FiO_2 = 80% → FiO_2 = 35% → FiO_2 = 80%

FiO_2 = 100% → FiO_2 = 80% → FiO_2 = 100%

PEEP = 5 cmH_2O /Vt 7-8ml/kg

30 cm H_2O /5-10 s

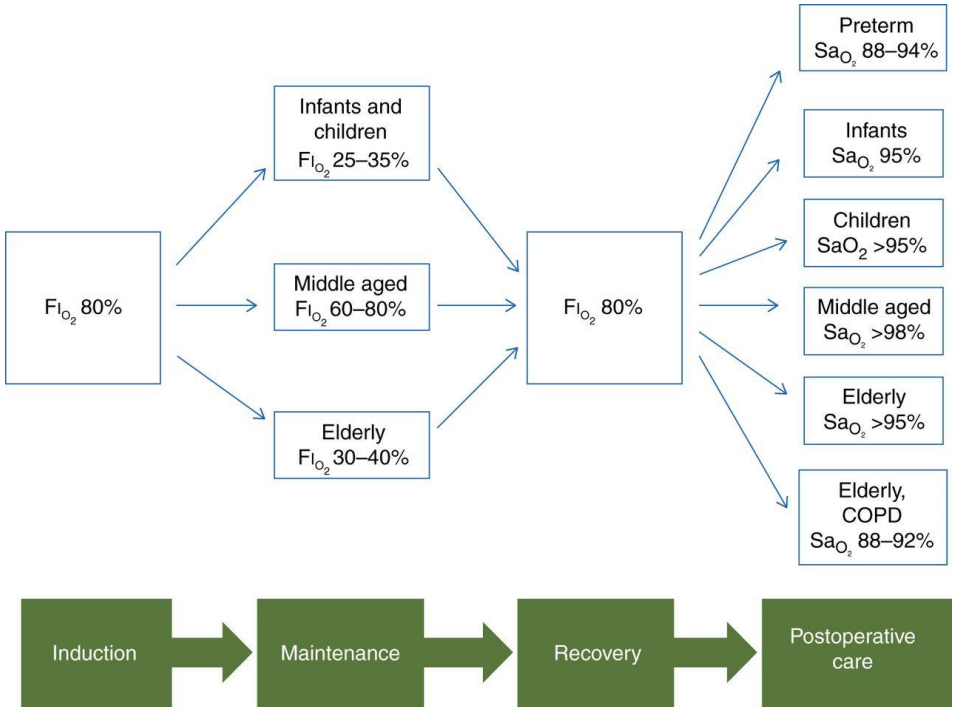
Comment prévenir?



Gérer sa FiO_2

Question	Statement/recommendation	Consensus (%)	Quality of evidence	Strength of recommendation
6.3	In the appropriate clinical scenario, the use of low FIO_2 (<0.4) during emergence from general anaesthesia can improve pulmonary function in the postoperative period.	71	☒☐☐☐	Weak

Suggested perioperative concentrations of inspired oxygen (FIO2) for different age groups under normal physiological conditions.



Comment prévenir?



Gérer sa FiO_2

Kim et al. BMC Anesthesiology (2020) 20:173
https://doi.org/10.1186/s12871-020-01090-y

BMC Anesthesiology

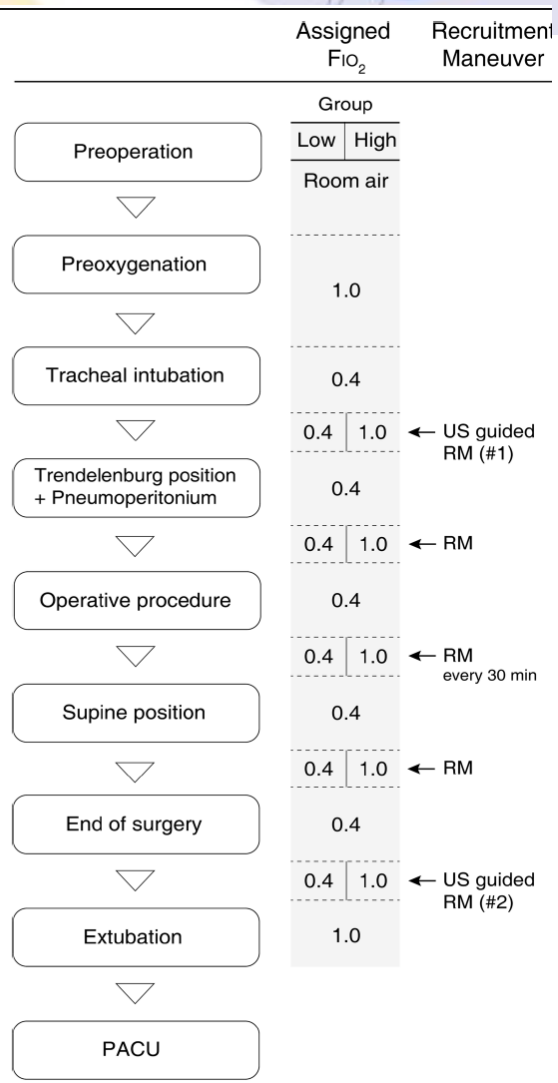
RESEARCH ARTICLE Open Access

Lung ultrasound score to determine the effect of fraction inspired oxygen during alveolar recruitment on absorption atelectasis in laparoscopic surgery: a randomized controlled trial

Table 2 Intraoperative and postoperative modified lung ultrasound scores

	Low-FIO_2 group (n = 44)	High-FIO_2 group (n = 46)	*P*-value
Baseline, after intubation			
Substantial atelectasis, n	12 (27.3%)	15 (32.6%)	0.747
Total modified LUSS	5.0 (3.0–8.0)	4.0 (4.0–6.0)	0.524
Anterior regions	0.0 (0.0–1.0)	0.0 (0.0–1.0)	0.538
Lateral regions	1.0 (0.0–2.5)	1.0 (0.0–2.0)	0.427
Posterior regions	4.0 (2.0–4.0)	3.0 (3.0–4.0)	0.839
End of surgery, before extubation			
Substantial atelectasis, n	21 (47.7%)	39 (84.8%)	< 0.001
Total modified LUSS	6.0 (4.5–9.0)	12.0 (9.0–14.0)	< 0.001
Anterior regions	0.0 (0.0–2.0)	2.0 (1.0–4.0)	< 0.001
Lateral regions	1.5 (0.0–2.5)	3.5 (2.0–4.0)	< 0.001
Posterior regions	4.0 (3.0–6.0)	6.0 (5.0–8.0)	< 0.001
Post-anesthesia care unit, before discharge			
Substantial atelectasis, n	22 (50.0%)	40 (87.0%)	< 0.001
Total modified LUSS	7.0 (5.0–10.0)	12.0 (10.0–16.0)	< 0.001
Anterior regions	1.0 (0.0–2.5)	3.0 (2.0–4.0)	< 0.001
Lateral regions	2.0 (1.0–3.5)	4.0 (2.0–5.0)	< 0.001
Posterior regions	4.0 (3.0–6.0)	7.0 (5.0–8.0)	< 0.001

Data are expressed as median (interquartile range), or number (%). Anterior, lateral, and posterior regions of the thorax were divided by the anterior and posterior axillary lines. LUSS, lung ultrasound score



Comment prévenir?



Mettre une PEEP

DOI: 10.1111/pan.13909

RESEARCH REPORT

Pediatric Anesthesia WILEY

Ventilation in pediatric anesthesia: A French multicenter prospective observational study (PEDIAVENT)

Marion Lebossé[1] | Delphine Kern[2] | Mathilde De Queiroz[1] | Nathalie Bourdaud[1] | Francis Veyckemans[3] | Dominique Chassard[1,4] | Florent Baudin[1,4] | on behalf of the ADARPEF (Association Des Anesthésistes Réanimateurs Pédiatriques d'Expression Française)[a]

Median: 4 [3-5] cmH2O

	All n = 701
Maintenance, n/N (%)	
TV ≥ 10 mL/kg	44/515 (8.8)
TV> 8mL/kg	254/515 (49.7)
ZEEP	56/599 (9.3)
PEEP < 3 cmH_2O	94/599 (15.7)

= 25%

Comment prévenir?



Mettre une PEEP…

au moins à 5 cmH_2O

ELSEVIER
Respiratory Physiology & Neurobiology
Volume 234, December 2016, Pages 9-13

Intratidal recruitment/derecruitment persists at low and moderate positive end-expiratory pressure in paediatric patients

Steffen Wirth, Lisa Artner, Tobias Broß, Sara Lozano-Zahonero, Johannes Spaeth, Stefan Schumann

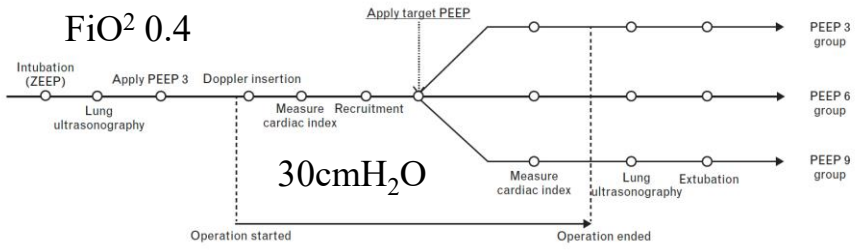
EJA
Eur J Anaesthesiol 2021; **38**:1019–1025

ORIGINAL ARTICLE

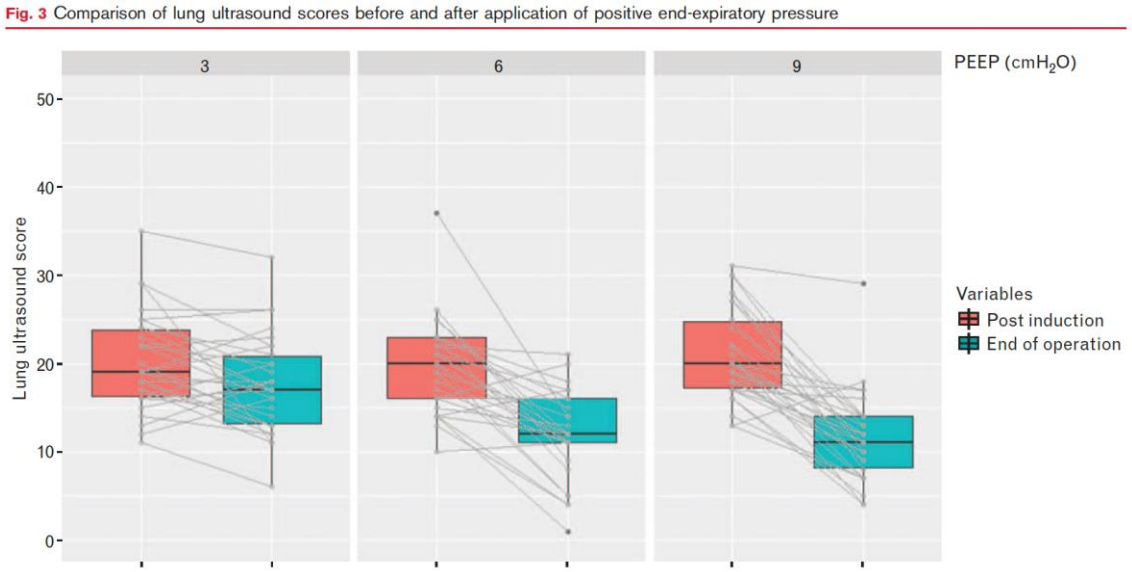
Optimal positive end-expiratory pressure to prevent anaesthesia-induced atelectasis in infants

A prospective, randomised, double-blind trial

Sujung Park, Jae Hoon Lee, Hyun Joo Kim, Haegi Choi and Jeong-Rim Lee



PEEP, positive end-expiratory pressure, ZEEP, zero end-expiratory pressure.



Comment prévenir?



Mettre une PEEP…

au moins à 5 cmH_2O

du début à la fin

EJA

Eur J Anaesthesiol 2021; **38**:41–48

ORIGINAL ARTICLE

Prevention of atelectasis by continuous positive airway pressure in anaesthetised children

A randomised controlled study

Cecilia M. Acosta, Maria Paz Lopez Vargas, Facundo Oropel, Lisandro Valente, Lila Ricci, Marcela Natal, Fernando Suarez Sipmann and Gerardo Tusman

Fig. 3. The aeration score during the study

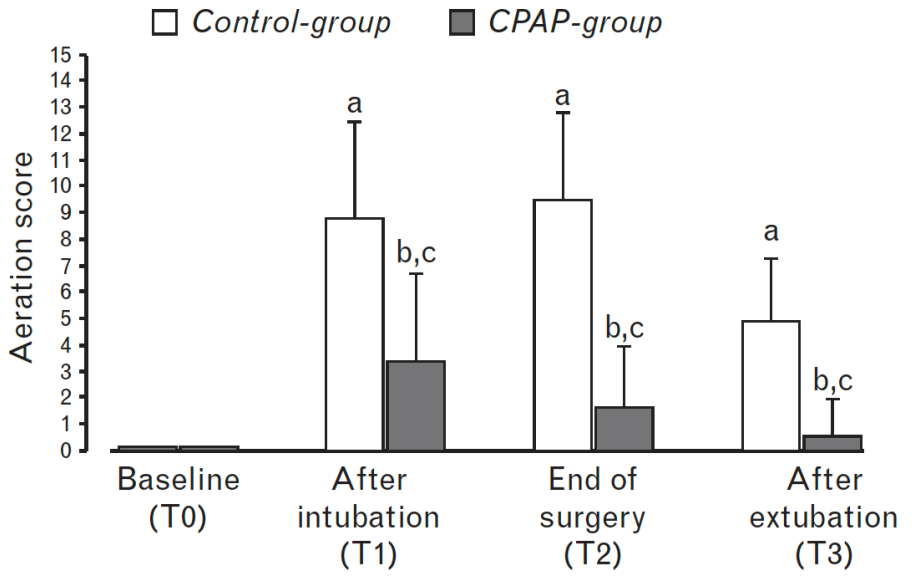
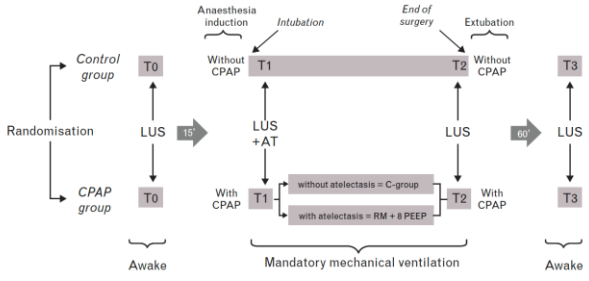


Fig. 1. Diagram of the protocol



Comment prévenir?



Pediatric Anesthesiology
ORIGINAL CLINICAL RESEARCH REPORT

Application of a High-Flow Nasal Cannula for Prevention of Postextubation Atelectasis in Children Undergoing Surgery: A Randomized Controlled Trial

Ji-Hyun Lee, MD, PhD, Sang-Hwan Ji, MD, Young-Eun Jang, MD, Eun-Hee Kim, MD, Jin-Tae Kim, MD, PhD, and Hee-Soo Kim, MD, PhD

O2 lunette 1 à 2L vs HFNC 2L/Kg/min Fio2 60% puis titrée

Table 2. Lung Ultrasound Measurements of the Control and HFNC Groups

	Control (n = 38)	P[a]	HFNC (n = 40)	P[b]	P[c]
At the end of surgery (T1)					
Consolidation score	9 (7–10.25 [0–28])		10 (8–12 [3–19])		.057
B-line score	10 (8–12 [0–21])		10 (8–11.75 [3–21])		.824
Significant atelectasis[d]	32 (84.2%)		38 (95%)		.149
At PACU discharge (T2)		T1 versus T2		T1 versus T2	
Consolidation score	3 (2–4 [0–24])	<.001	0 (0–1 [0–4])	<.001	<.001
B-line score	4 (2–6.24 [0–14])	<.001	1 (0–2.75 [0–8])	<.001	<.001
Significant atelectasis[d]	6 (15.8%)	<.001	0	<.001	.011

Comment traiter?

Received: 18 October 2021 | Revised: 11 November 2021 | Accepted: 15 November 2021
DOI: 10.1111/pan.14335

EDUCATIONAL REVIEW

Pediatric Anesthesia WILEY

Atelectasis and lung recruitment in pediatric anesthesia: An educational review

Suze Bruins[1] | David Sommerfield[1,2,3] | Neil Powers[4] | Britta S. von Ungern-Sternberg[1,2,3]

Recruter !

39e CONGRÈS ANNUEL DE L'ADARPEF
Association des Anesthésistes Réanimateurs Pédiatriques d'Expression Française
25 & 26 MARS 2022 MONTPELLIER Le Corum

TABLE 1 Recruitment techniques used in pediatric studies where the effect of recruitment on lung aeration was apparent and measured on imaging

Author(s)	Subjects	Type of study	Description of recruitment maneuver	Changes in lung aeration monitored by:	Outcome
Method one					
Jang et al.[11]	<3 years ASA NS $n = 73$	RCT	30–40 cmH_2O of continuous positive airway pressure via a closed system for approximately 5–10 s until no collapsed lung areas were detected on LUS. After the RM, PEEP of 7 cmH_2O was applied.	LUS	Regular alveolar recruitment reduced the incidence of atelectasis at the end of surgery in patients undergoing general anesthesia in the prone position.
Mansfield et al.[47]	0–5 years ASA NS $n = 94$	Retrospective/ prospective audit	Three breaths of 30 cmH_2O of continuous positive airway pressure for 15–20 s. After the RM, PEEP of 8 cmH_2O was applied.	CT	CT chest atelectasis scores of 0–1 improved from 45% to 75%.
Newman et al.[46]	2 month – 5.1 years ASA NS $n = 42$ (56 scans)	Retrospective/ prospective study	10–12 3 s inspirations to a positive inspiratory pressure of 40 cmH_2O using a PEEP of 6 cmH_2O between inspirations.	CT	CT images considered very good to excellent quality improved from 24% to 70%.
Song et al.[45]	<5 years ASA NS Cardiac surgical patients $n = 120$	RCT	Under real-time ultrasound guidance, a 5 cmH_2O stepwise increase in airway pressure from 10 cmH_2O was manually applied until no collapsed lung areas were visible on the ultrasound. Each level of continuous positive airway pressure was applied for 5 s. The maximum airway pressure was limited to 40 cmH_2O PEEP 5 cmH_2O.	LUS	US-guided RM decreased postoperative desaturation events and shortened the duration of mechanical ventilation in pediatric cardiac patients.
Song et al.[6]	<1 years ASA I-II $n = 40$	RCT	Under real-time ultrasound guidance, a 5 cmH_2O stepwise increase in airway pressure from 10 cmH_2O was manually applied until no collapsed lung areas were visible on the ultrasound. The maximum airway pressure was limited to 40 cmH_2O. PEEP 5 cmH_2O.	LUS	US-guided RM proved useful in reducing the incidence of anesthesia-induced atelectasis in infants.
Tusman et al.[5]	6 month–6 years ASA I-II $n = 42$	RCT	PIP of 40 cmH_2O and a PEEP of 15 cmH_2O for 10 breaths. After the RM, PEEP of 5 cmH_2O was applied.	MRI	Frequency of atelectasis was much less following the alveolar recruitment strategy, compared with children who did not have the maneuver performed.

Comment traiter?



Recruter !

Author(s)	Subjects	Type of study	Description of recruitment maneuver	Changes in lung aeration monitored by:	Outcome
Method Two					
Acosta et al.[43]	6 month – 7 years ASA I-II *n* = 42	RCT	PCM with a constant driving pressure of 15 cmH_2O. PEEP was increased in steps of 5 cmH_2O, from 5 to 15 cmH_2O, every three breaths. The target recruitment pressure of 30 cmH_2O was maintained for 10 breaths, corresponding to approximately 30 s. After the RM, 8 cmH_2O of PEEP was applied.	LUS	Lung aeration significantly improved during and after capnoperitoneum in the lung RM group.
Zhu et al.[48]	1–6 years ASA I-II *n* = 60	RCT	Recruitment maneuvers were performed, in pressure-controlled mode, with a constant driving pressure of 15 cmH_2O. PEEP was increased in steps of 5 cmH_2O, from 5 to 15 cmH_2O, every three breaths. The target recruitment pressure of 30 cmH_2O was maintained for 10 breaths.	LUS	Patients receiving RM had lower median (IQR) ultrasound scores (lower score = better lung aeration) compared with the control group immediately after surgery and after extubation.
Tusman et al.[44]	3 years ASA I *n* = 1	Case report	Application of a constant driving pressure that resulted in a V_t of 8 ml/kg (10–15 cmH_2O in normal lungs), PEEP was then increased in steps of 5 cmH_2O, from 5 to 20. Each PEEP level was maintained for at least five breaths. Driving pressure was increased to 20 cmH_2O to reach opening pressure of 40 cmH_2O for 10 breaths. PEEP was reduced in 2 cmH_2O decrements until closing pressure identified.	LUS	LUS can be used in real-time to identify complete resolution of atelectasis.
He et al (REF)	0–3 years ASA II-III *N* = 84	RCT	Post-right thoracotomy for cardiac surgery, patients randomized to either RM in supine position or right lateral position. PCM was used for RM. Constant driving pressure of 15 cmH_2O with 5 cmH_2O increments in PEEP until 30 cmH_2O peak pressure. Each PEEP step was held for 5 s and 10 s at peak pressure. Reduction of pressure in stepwise fashion until 5 cmH_2O.	LUS	Postural RM is superior to RM in supine position following right-sided thoracotomy in young children.

Comment traiter?



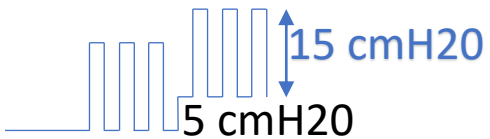
Recruter !

Avec des niveaux de pression élevés

1 groupe standard = 30 cmH_2O

1 groupe LUS (max 40 cmH_2O) ---> MEDIAN = 35 cmH2O

Max 30 cmH_2O ----------



EJA

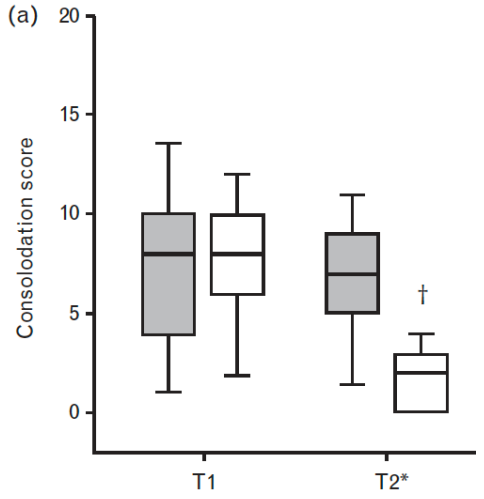
Eur J Anaesthesiol 2020; **37**:719–727

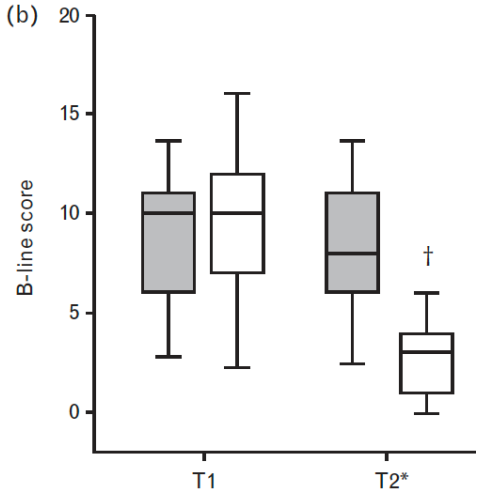
ORIGINAL ARTICLE

Effect of an ultrasound-guided lung recruitment manoeuvre on postoperative atelectasis in children

A randomised controlled trial

Ji-Hyun Lee, Seungeun Choi, Sang-Hwan Ji, Young-Eun Jang, Eun-Hee Kim, Hee-Soo Kim and Jin-Tae Kim





Comment traiter?

39e CONGRÈS ANNUEL DE L'ADARPEF

Association des Anesthésistes Réanimateurs Pédiatriques d'Expression Française

Recruter !

En monitorant le poumon …

Journal of Clinical Anesthesia 77 (2022) 110626

Contents lists available at ScienceDirect

Journal of Clinical Anesthesia

journal homepage: www.elsevier.com/locate/jclinane

Original Contribution

Evaluation of atelectasis using electrical impedance tomography during procedural deep sedation for MRI in small children: A prospective observational trial

Thomas Riva [a,b,*], Fabio Pascolo [a], Markus Huber [a], Lorenz Theiler [c], Robert Greif [a,d], Nicola Disma [b], Alexander Fuchs [a], Joana Berger-Estilita [a,e,1], Thomas Riedel [f,g,1]

Table 3
Proportion of silent spaces and global inhomogeneity indices at each analysis point. Data are summarized as Median and interquartile ranges.

Timepoint	Proportion of silent spaces (%)	Global inhomogeneity index
T1 (Before induction of anesthesia)	5 [2;14]	0.57 [0.55;0.58]
T2 (2 min after the end of induction, before start of the MRI)	10 [7;14]	0.56 [0.53;0.59]
T3 (2 min after completion of the MRI)	12 [5;23]	0.56 [0.54;0.59]
T4 (2 min after the end of anesthesia, before transport to the PACU)	12 [7;24]	0.57 [0.54;0.60]

EJA

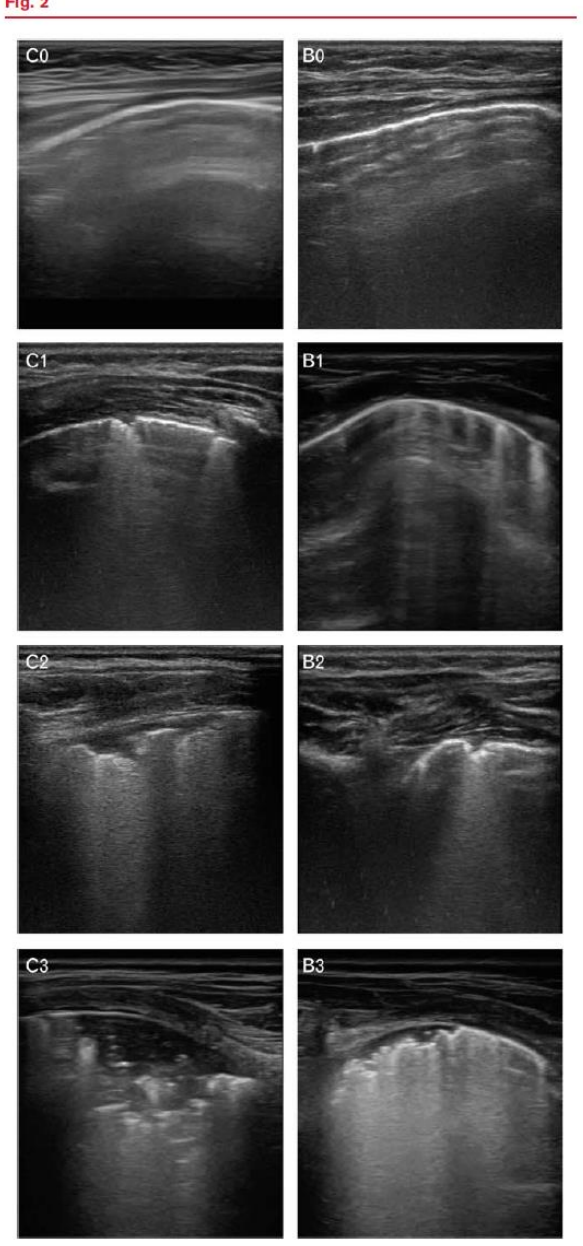
Eur J Anaesthesiol 2020; **37**:719–727

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Ji-Hyun Lee, Seungeun Choi, Sang-Hwan Ji, Young-Eun Jang, Eun-Hee Kim, Hee-Soo Kim and Jin-Tae Kim



Scoring system for juxtapleural consolidation and B-lines based on lung ultrasound findings. The degree of juxtapleural consolidation (C) and B-lines (B) is graded in accordance with the method described by Song *et al.*[9] C0, no consolidation; C1, minimal juxtapleural consolidation; C2, small-sized consolidation; and C3, large-sized consolidation. B0, fewer than three isolated B-lines; B1, multiple well defined B-lines; B2, multiple coalescent B-lines; and B3, white lung.

Quel Bénéfice ?



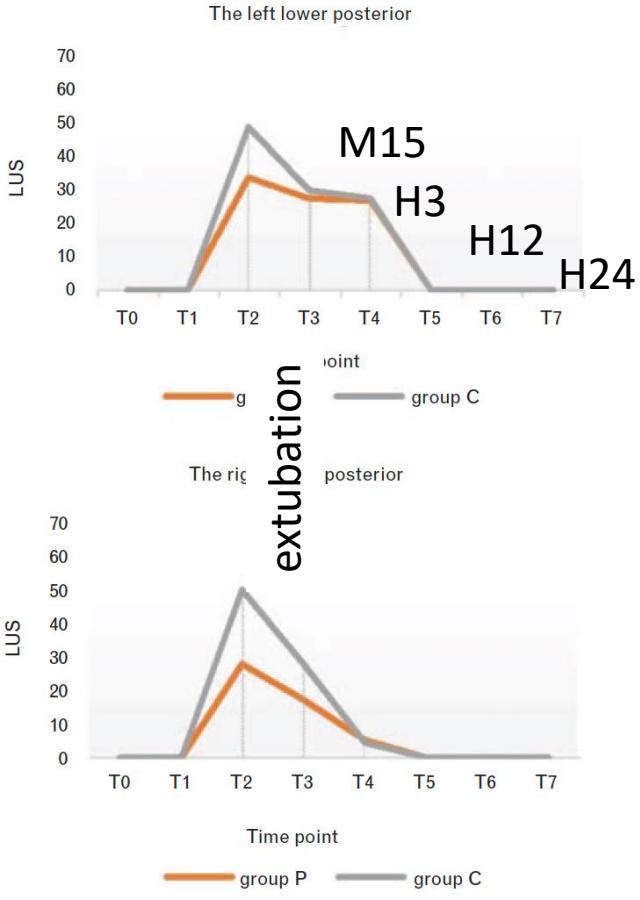
EJA
OPEN
Eur J Anaesthesiol 2021; **38**:1026–1033

ORIGINAL ARTICLE

Effects of positive end-expiratory pressure/recruitment manoeuvres compared with zero end-expiratory pressure on atelectasis in children

A randomised clinical trial

Change Zhu, Saiji Zhang, Junli Dong and Rong Wei



Journal of Clinical Anesthesia 77 (2022) 110626
Contents lists available at ScienceDirect
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journal homepage: www.elsevier.com/locate/jclinane

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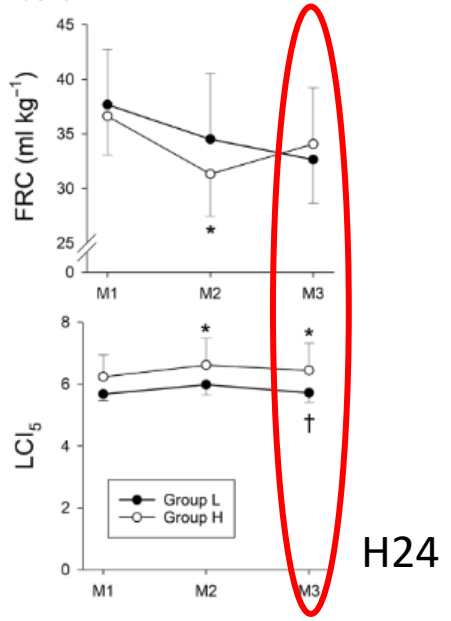
Thomas Riva[a,b,*], Fabio Pascolo[a], Markus Huber[a], Lorenz Theiler[c], Robert Greif[a,d], Nicola Disma[b], Alexander Fuchs[a], Joana Berger-Estilita[a,e,1], Thomas Riedel[f,g,1]

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T4 (2 min after the end of anesthesia, before transport to the PACU)	12 [7;24]	0.57 [0.54;0.60]
T5 (Before discharge to home)	3 [2;11]	0.56 [0.54;0.57]

CLINICAL INVESTIGATION

High inspired oxygen fraction impairs lung volume and ventilation heterogeneity in healthy children: a double-blind randomised controlled trial

Béatrice de la Grandville[1,2,3], Ferenc Petak[4], Gergely Albu[2,3], Sam Bayat[2,3], Isabelle Pichon[2,3] and Walid Habre[2,3,*]



Quel Bénéfice ?



DOI: 10.1111/pan.13894

RESEARCH REPORT

Pediatric Anesthesia WILEY

Lung protective ventilation in infants undergoing cardiopulmonary bypass surgery for congenital heart disease: A prospective randomized controlled trial

Yuan Sun[1] | Sai-E Shen[1] | Xiao-Ming Deng[2] | Ying Cai[1] | Yi Du[1]

	LPV group (n = 39)	CV group (n = 38)	OR (95% CI)	P value
Post-CPB hypoxemia	9 (23.1%)	26 (68.4%)	0.138 (0.050-0.381)	<0.001
Pulmonary complications postoperative	20 (51.3%)	23 (60.5%)	0.686 (0.278-1.695)	0.414
ICU stay (days)	3 (3-5)	4 (3-7)	0.075 (0.070-0.080)	0.075

ZEEP 10-12ml/kg vs PEEP 6-8ml/kg

BJA

British Journal of Anaesthesia, 122 (5): 692–701 (2019)
doi: 10.1016/j.bja.2019.02.013
Advance Access Publication Date: 8 March 2019
Paediatric Anaesthesia

Lung protective ventilation during pulmonary resection in children: a prospective, single-centre, randomised controlled trial

Ji-Hyun Lee†, Jung-il Bae†, Young-Eun Jang, Eun-Hee Kim, Hee-Soo Kim and Jin-Tae Kim*

	Control group (*n*=55)	LPV group (*n*=55)	Odds ratio (95% CI)	P-value
Lung ultrasound				
Consolidation score	9 (6, 11.25)	2 (1, 4)		<0.001
Anterior	3 (1, 4)	0 (0, 1)		<0.001
Lateral	4 (3, 5)	1 (0, 2)		<0.001
Posterior	3 (1, 4)	0 (0, 1)		<0.001
B-lines score	11 (9, 13)	3.5 (1, 6)		<0.001
Anterior	4 (2, 5)	1 (0, 2)		<0.001
Lateral	5 (3, 5)	2 (0, 3)		<0.001
Posterior	3 (1, 4)	0 (0, 2)		<0.001
Postoperative pulmonary complications*	14 (25.5)	5 (9.1)	3.41 (1.13–10.27)	0.021
Respiratory infection	3 (5.5)	1 (1.8)		
Pleural effusion	3 (5.5)	2 (3.6)		
Atelectasis	3 (5.5)	0		
Pneumothorax	5 (9.1)	2 (3.6)		

ZEEP 10 puis 8 ml/kg vs PEEP = 6 cmH_2O 6 puis 4ml/kg

CONCLUSION



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

5. Normoxemia
6. Normocapnia