Paediatric ventilation during anaesthesia

LJ VAN OBBERGH
HUB ERASME
BRUSSELS
BELGIUM

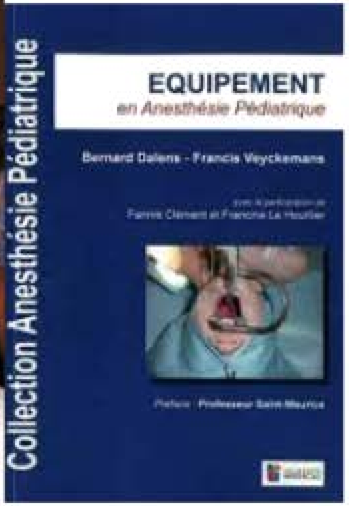
Topics....

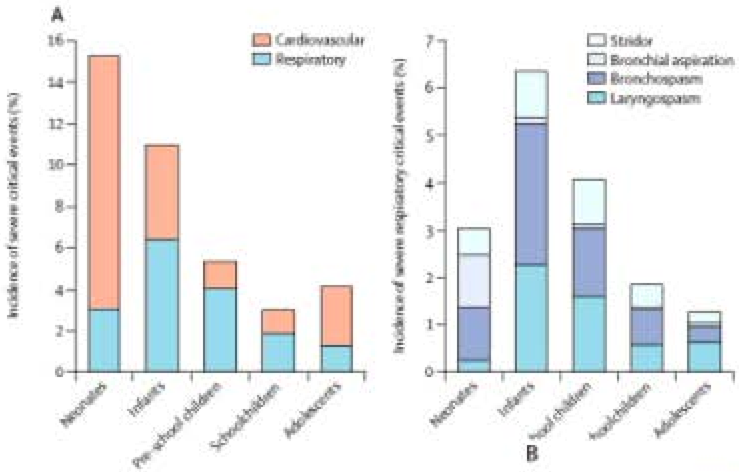
- Anatomical specifities
- Intubation: some reminders
- Physiological specificities.
- Protective ventilation

Professor Emeritus Henry Halliday from Queen's University Belfast has been awarded the highest honour bestowed by the Royal College of Paediatrics and Child Health - the James Spence Medal - for his outstanding contributions to neonatal care

http://walidhabre.org

The idea for having a website appeared to me following my wish to share with the community my scientific and professional experience in the field of paediatric anesthesia and respiratory pathophysiology.

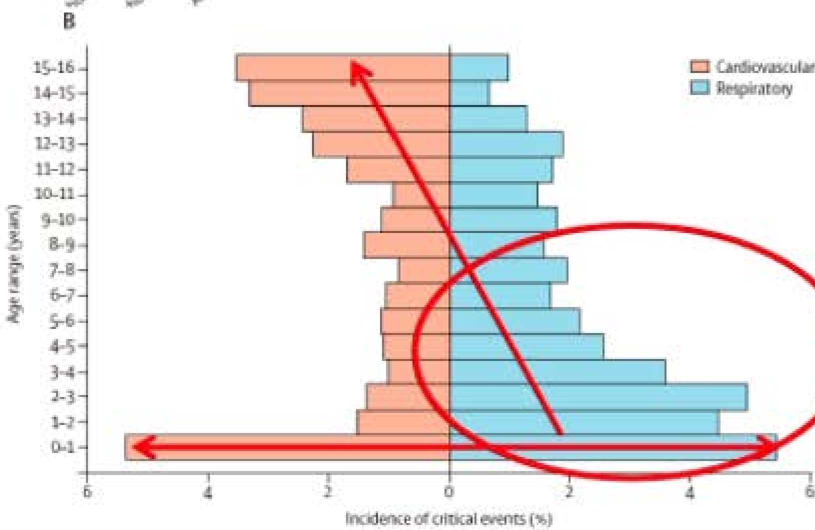




Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe

Lancet Respir Med 2017

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*



Habre Lancet 2017

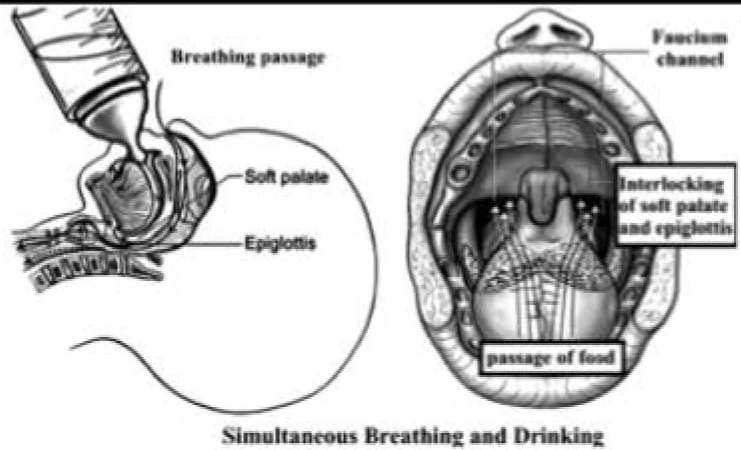
Ventilation in pediatric anesthesia: A French multicenter prospective observational study (PEDIAVENT)

Pediatric Anesthesia. 2020;30:912–921.

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]

Conclusions: Ventilatory practices in children were heterogenous, and a large proportion of children were not ventilated as it is currently recommended by some experts.

Some



Can J Anesth/J Can Anesth (2011) 58:476–477

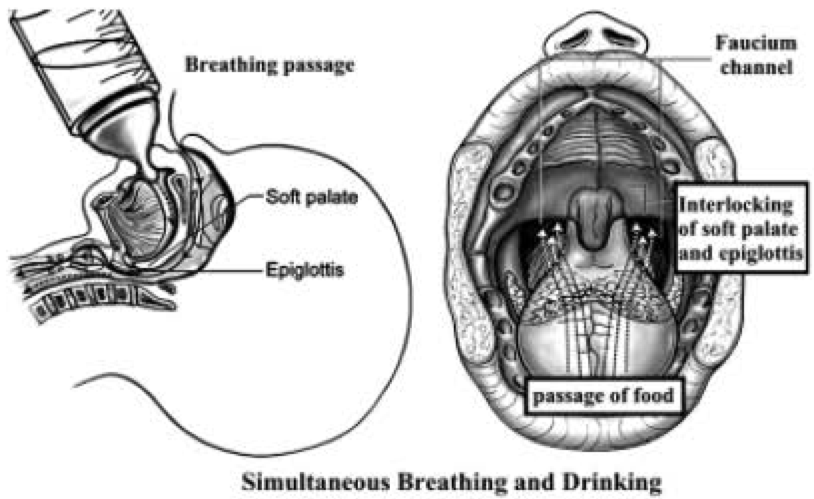
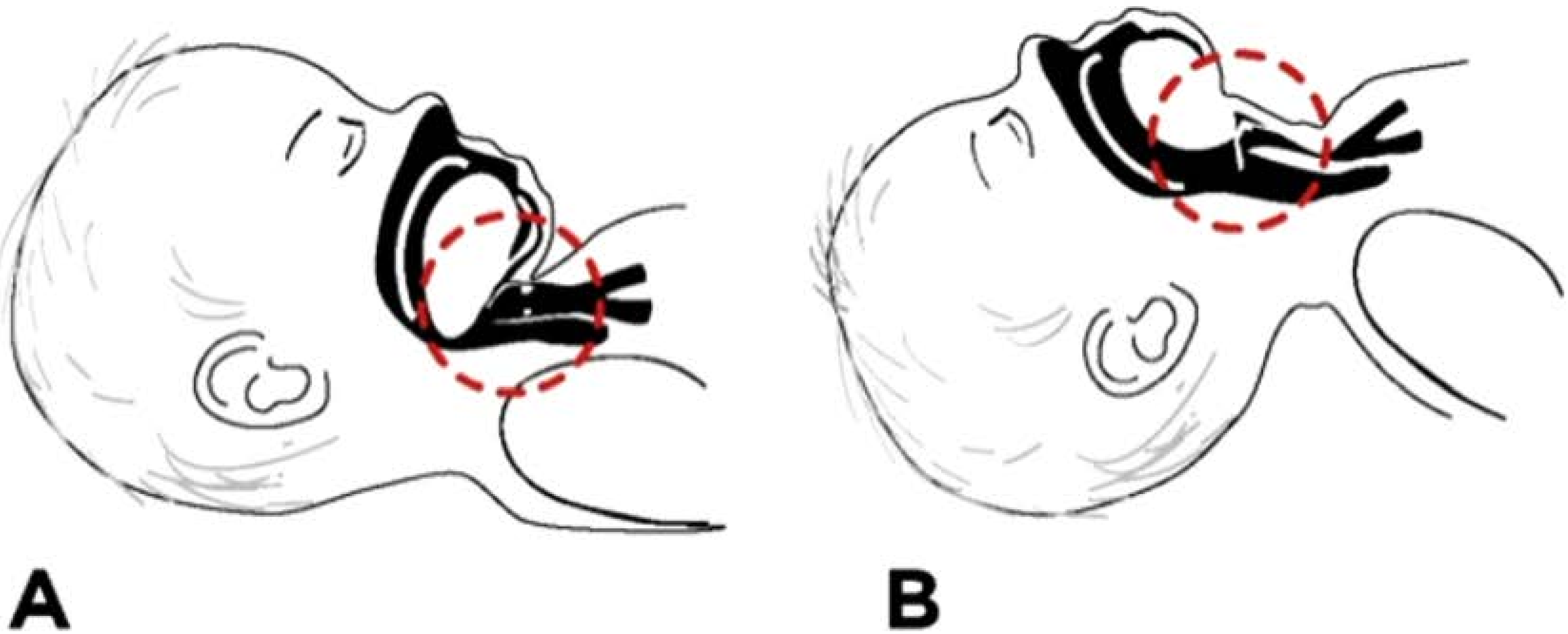
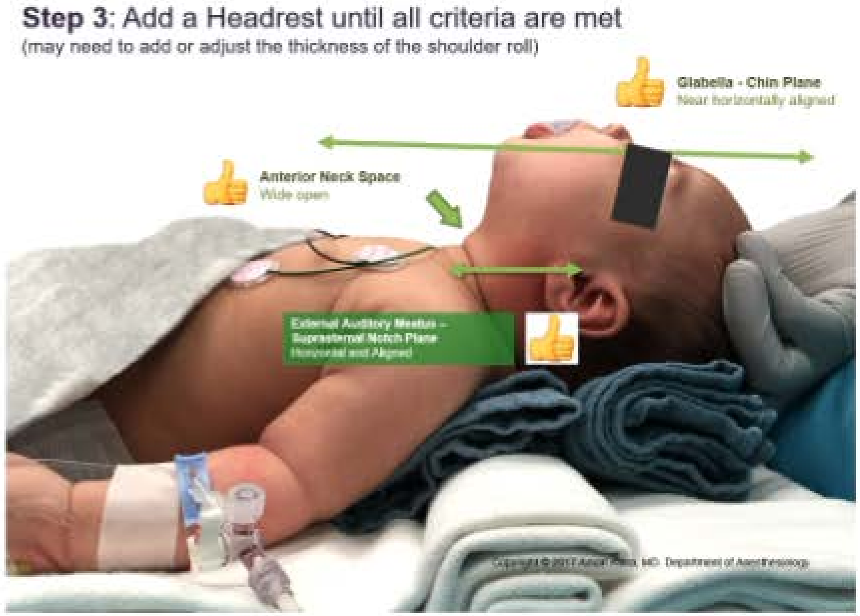


Figure The interlocking soft palate and epiglottis in infants due to the elevation of the larynx allows simultaneous breathing and drinking. (*left*) The position of the infant's tongue entirely within the oral cavity allows the distinctly omega-shaped epiglottis to interlock with the soft palate when feeding. (*right*) Milk flows through the lateral faucium channels. (Reproduced and adapted with permission from *Principles of Airway Management*) [3]

Search the best way to obtain the sniffing position



The larynx and trachea of the infant and toddler are so soft that extreme flexion (**A**) or extension (**B**) of the head can obstruct the airway.

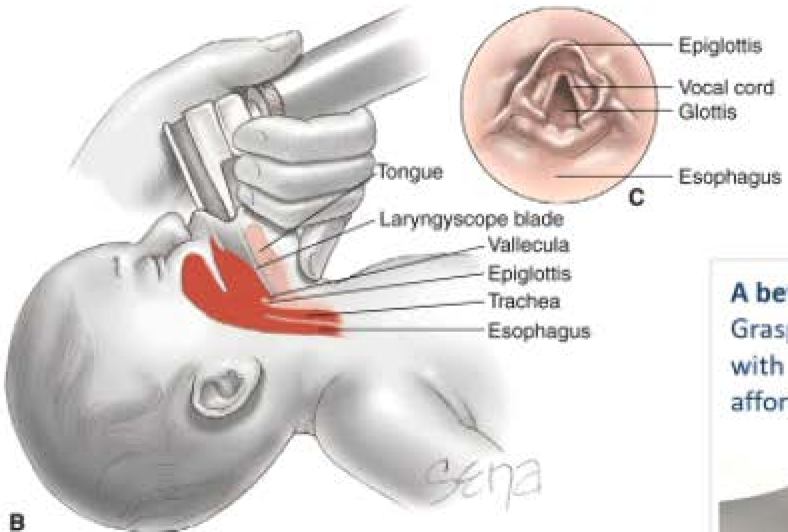


Search the best way to obtain the sniffing position

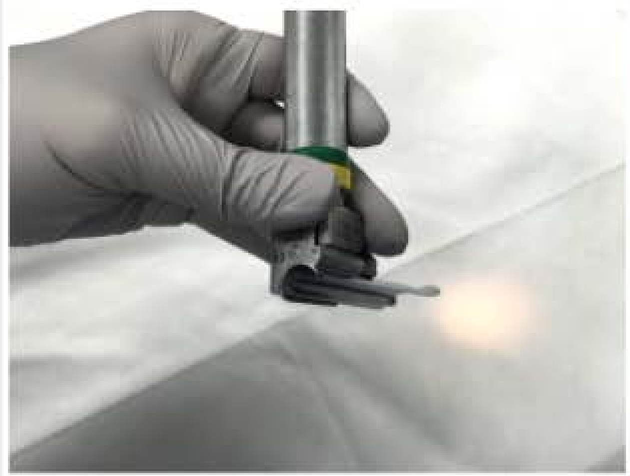
A

B

Keep your fingers on the bones



A better way to hold the laryngoscope!
Grasping the handle near the hinge as shown with the thumb stabilizing the base of the blade affords better precision and control.

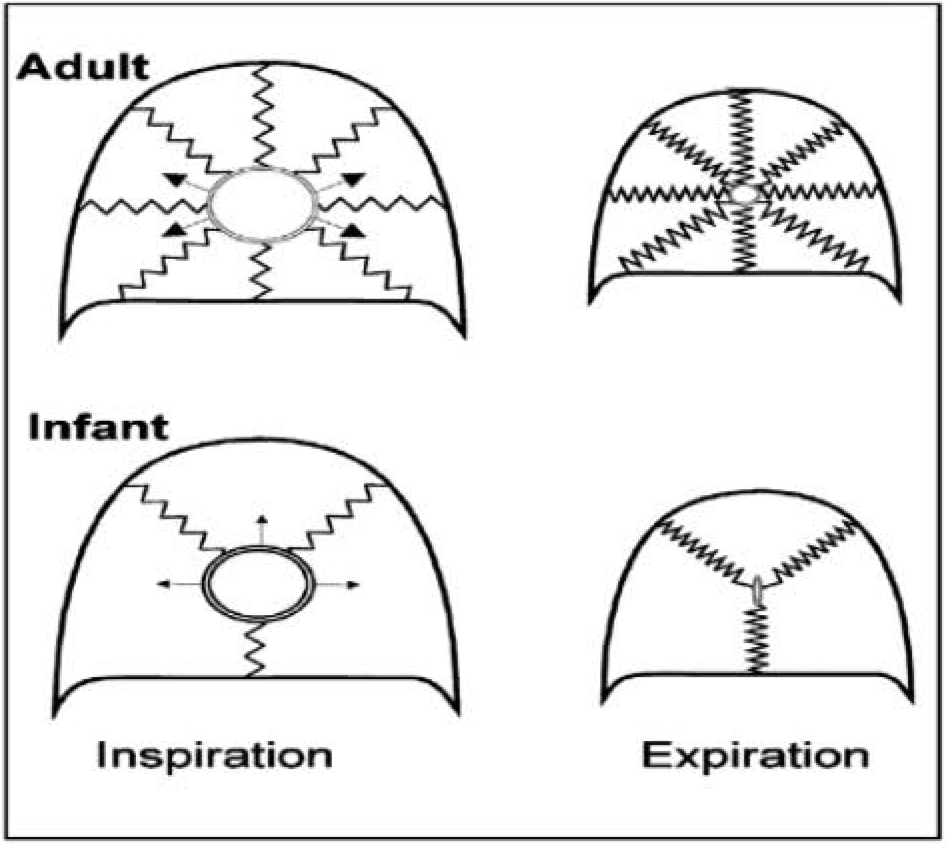


Infant

Toddler

Adult

Be aware of the angle !!!!!! Don’t try to see the tube entering the larynx…..



Pediatric Anesthesia, Volume: 32, Issue: 2, Pages: 108-117, First published: 07 December 2021, DOI: (10.1111/pan.14362)

Effects of anaesthesia on paediatric lung function

D. Trachsel[1], J. Svendsen[2], T. O. Erb[3] and B. S. von Ungern-Sternberg[4,5,*]

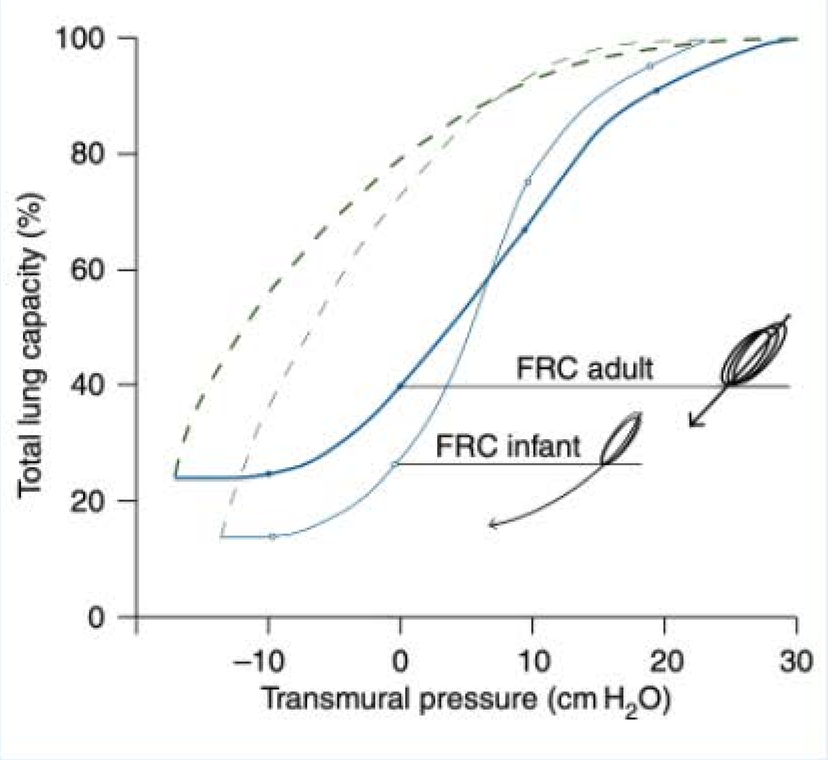
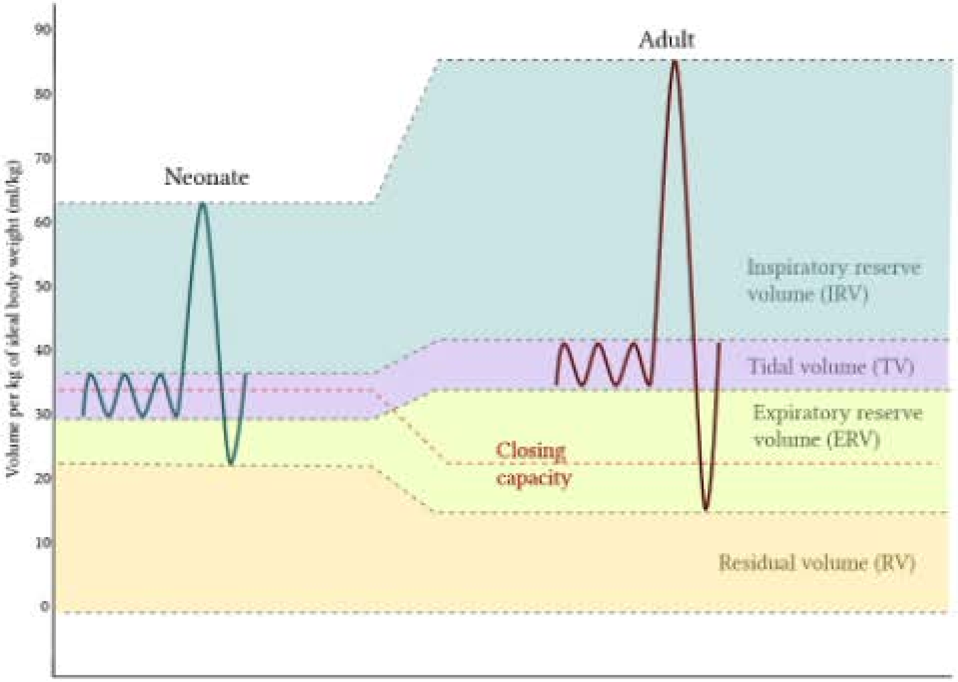
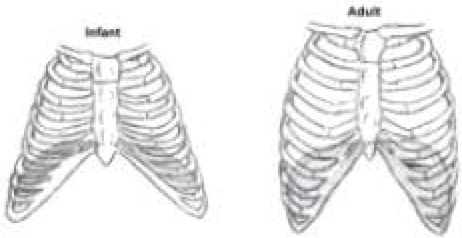


Fig 2 Pressure-volume relationship of the respiratory system in the muscle-relaxed adult subject (thick lines) and in the muscle-relaxed infant (thin lines). Loops indicated tidal breathing which in adults starts from a higher functional residual capacity (FRC) than in infants. Note that residual volume relative to total lung capacity (TLC) is lower in infants than in adults. Adapted from Agostoni E[32] and others.

British Journal of Anaesthesia, 117 (2): 151–63 (2016)



Neonate
Adult
Volume per kg of ideal body weight (ml/kg)
90
80
70
60
50
40
30
20
10
0
Inspiratory reserve volume (IRV)
Tidal volume (TV)
Expiratory reserve volume (ERV)
Closing capacity
Residual volume (RV)



Infant
Adult

Young infants maintain their FRC by ....

- Sustaining tonic activities of inspiratory muscles throughout the respiratoy cycle
- Narowing the glottis during expiration
- Nasal breathing
- Inspiration starting in midexpiration
- Most of this is lost during anesthesia

- Adapted from Smith's anesthesia for infants and children
- PJ Davis and FP Cladis

Fewer alveoli thus lower lung compliance

Diaphragmatic respiration

Closing volume above FRC

Babies are abdominal breather

Diaphragm is essential
Stomach distension limits TV

Loss of « autoPEEP »
By oral breathing

Micro- atelectasis are easier observed in babies

REVIEW | *Physiology in Medicine*

J Appl Physiol 122: 1516–1522, 2017.

Physiology in Medicine: Understanding dynamic alveolar physiology to minimize ventilator-induced lung injury

Gary F. Nieman,[1] Josh Satalin,[1] Michaela Kollisch-Singule,[1] Penny Andrews,[2] Hani Aiash,[1,3] Nader M. Habashi,[2] and Louis A. Gatto[1,4]

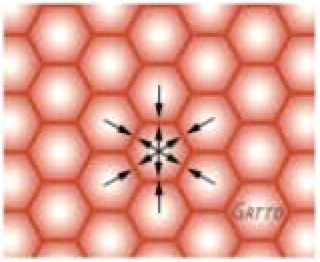


Fig. 1. Interdependent alveoli with shared alveolar walls represented as hexagons. This homogeneous anatomical design assists in stabilizing alveoli preventing collapse during expiration and overdistension during inspiration, since there is no pressure (arrows) gradient between alveoli (opposing arrows of equal force). Only ~2% change in alveolar area is measured between inspiration (Supplemental Animation S1*A*) and expiration (Supplemental Animation S1*B*) using in vivo microscopy.

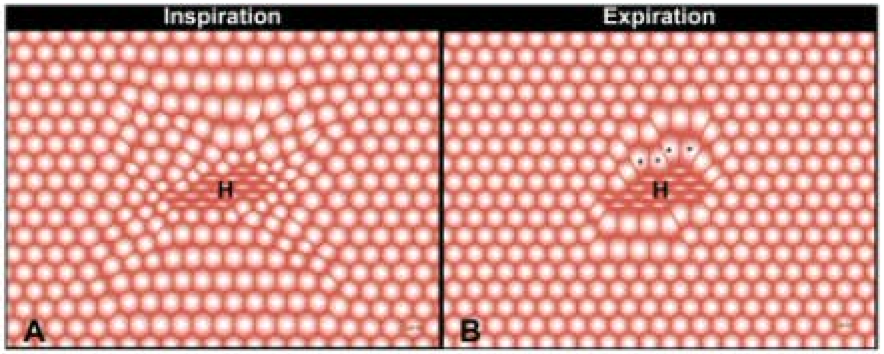
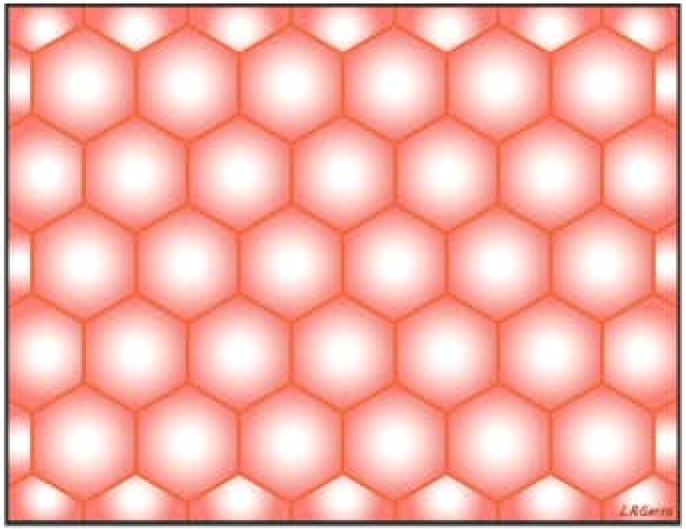
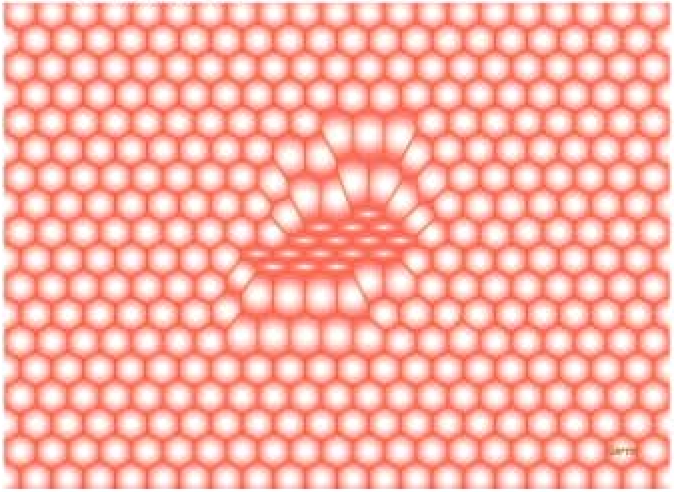


Fig. 2. Heterogeneous alveolar injury depicted as a cluster of collapsed alveoli in the center of the field (H) surrounded by open interdependent alveoli (hexagons). Note the distortion and overdistension of the patent alveoli adjacent to the collapsed alveolar cluster (asterisks), with more overdistension alveoli at expiration (*B*) compared with inspiration (*A*). The larger the change in size of these alveoli with each breath, the larger the dynamic strain-induced tissue damage. These dynamic changes can be seen in Supplemental Animation S2.



INSPIRATION

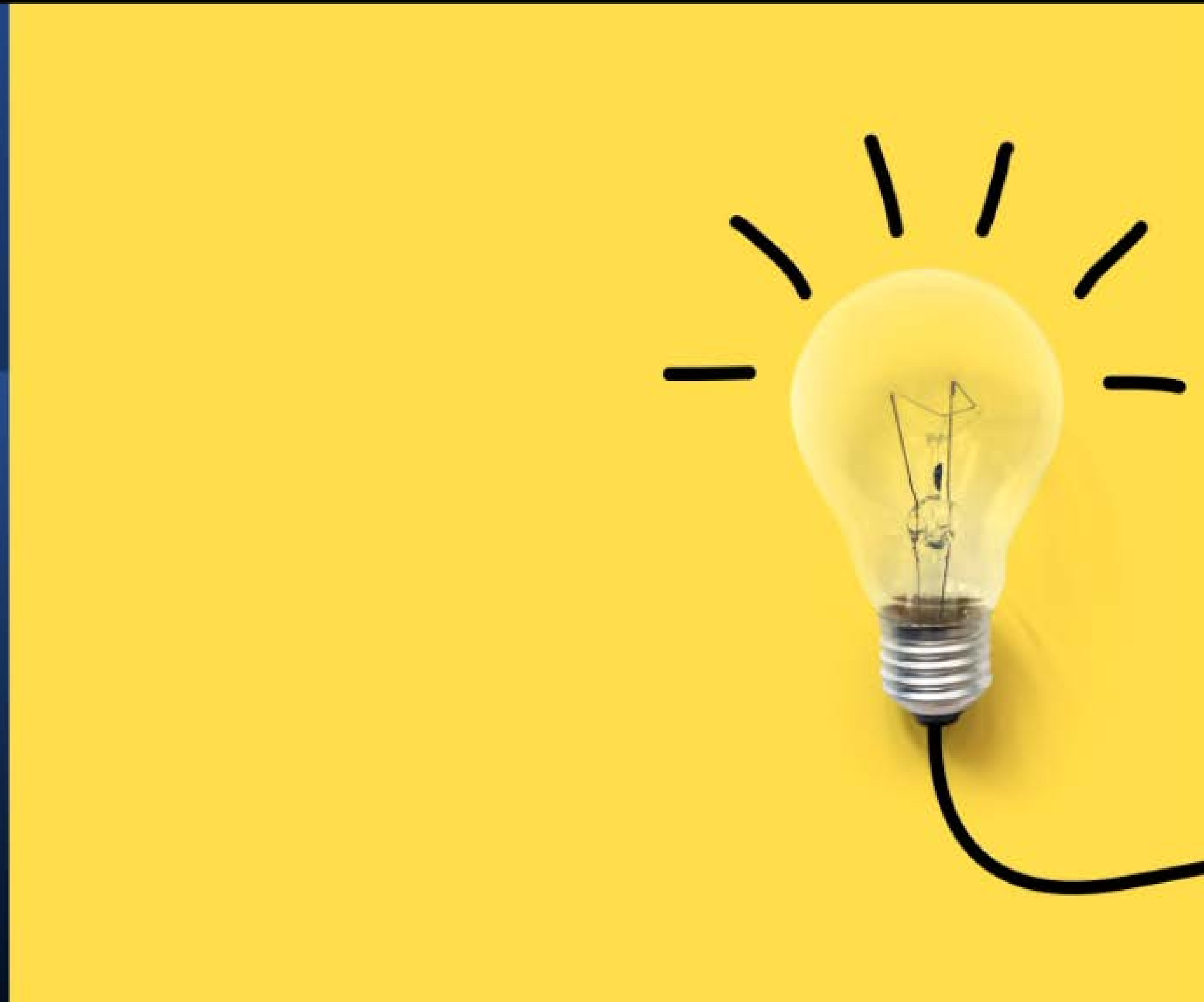


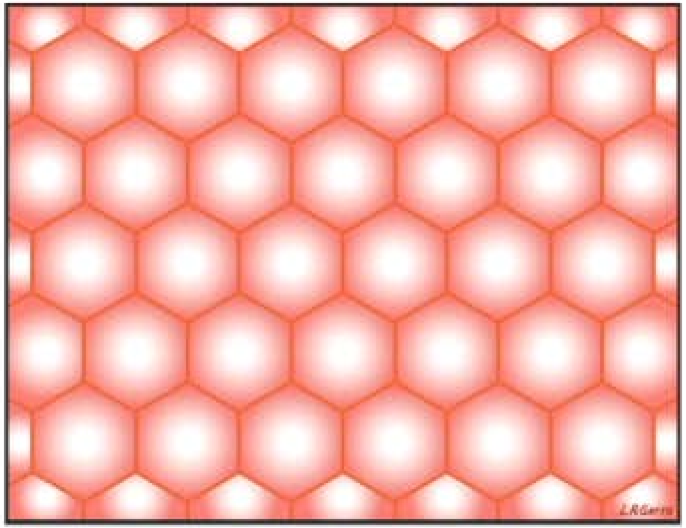
Peak airway pressure is lower during pressure-controlled than during manual facemask ventilation for induction of anesthesia in pediatric patients—a randomized, clinical crossover trial

Journal of Anesthesia (2019) 33:33–39

Ulrich Goebel[1,2] · Stefan Schumann[1,2] · Steffen Wirth[1,2]

Conclusion Pressure-controlled facemask ventilation during induction of anesthesia in pediatric patients results in lower airway pressure, and lower flow rates compared to manual ventilation, at comparable tidal and minute volumes.





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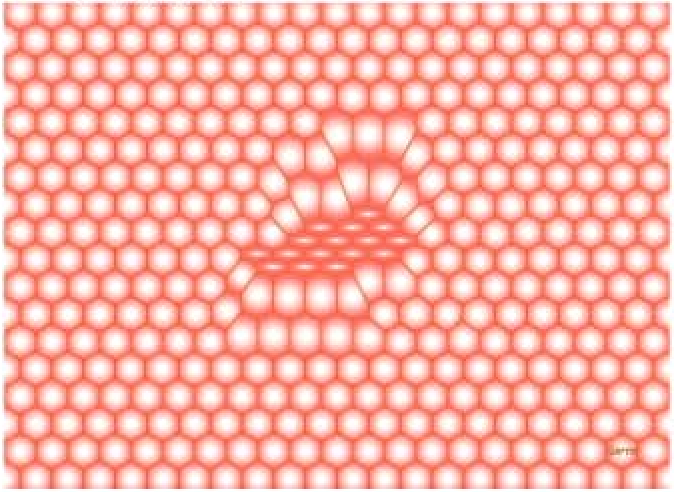

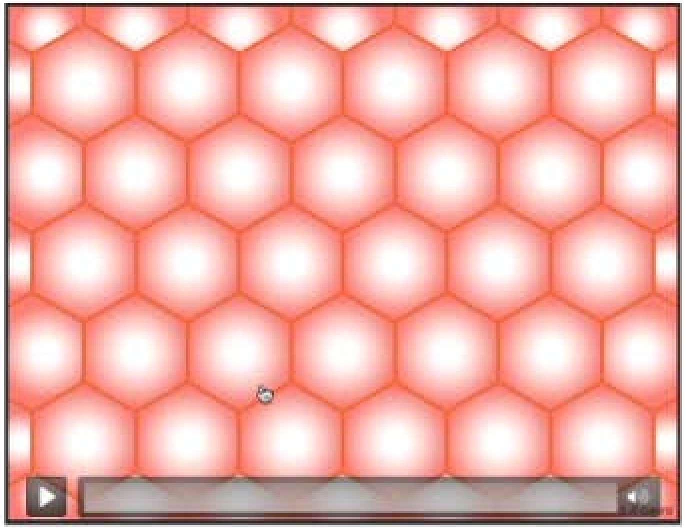

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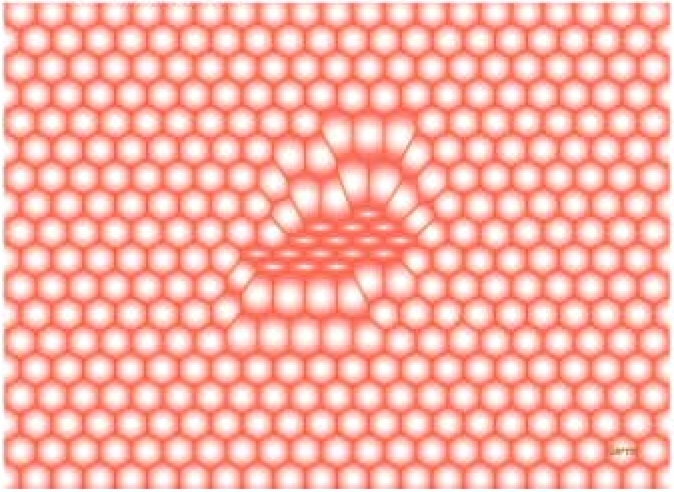

Keep this in mind early during the induction…

Peak airway pressure is lower during pressure-controlled than during manual facemask ventilation for induction of anesthesia in pediatric patients—a randomized, clinical crossover trial

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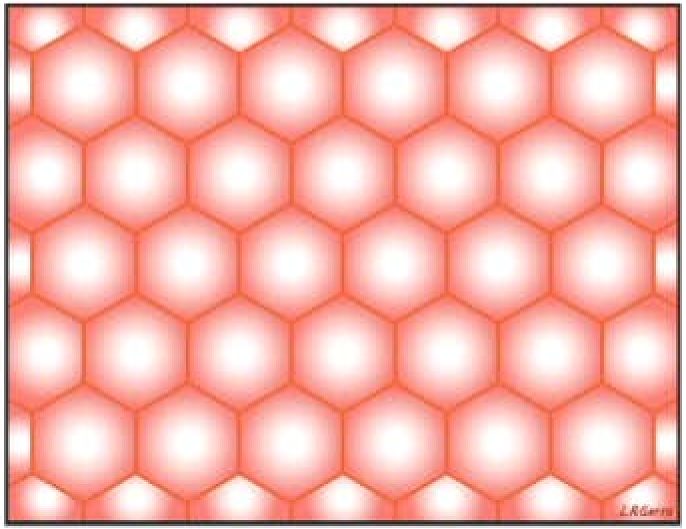

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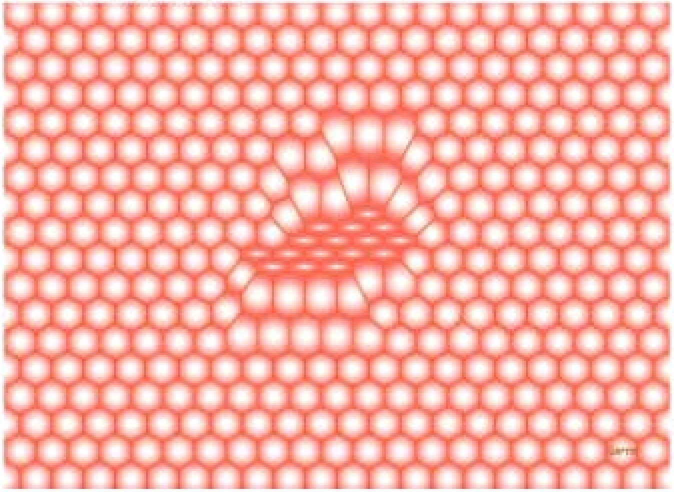

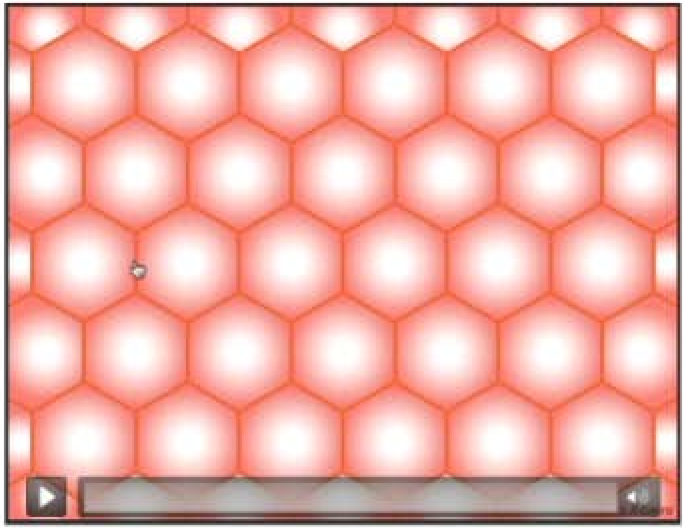

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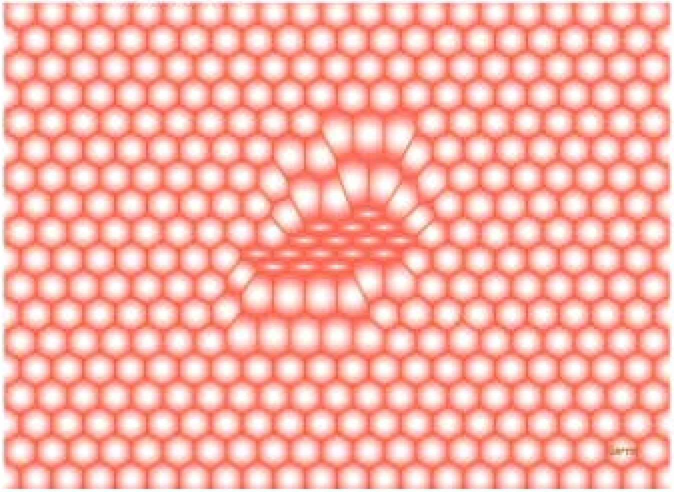

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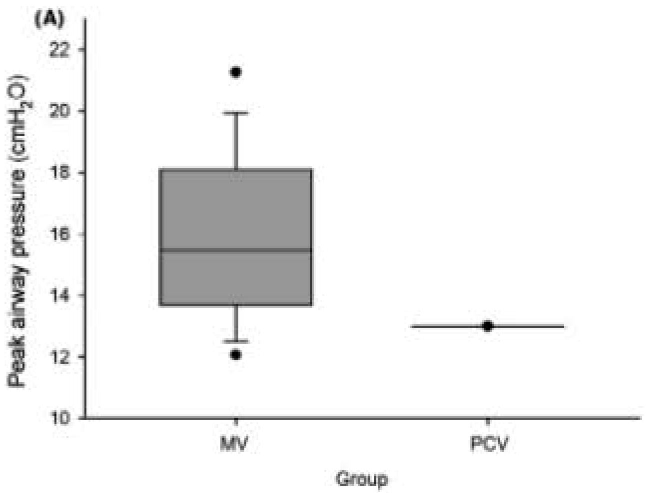
Manual vs pressure-controlled facemask ventilation during the induction of general anesthesia in children: A prospective randomized controlled study

Pediatric Anesthesia. 2019;29:331–337.

TABLE 2 Incidence of gastric insufflation and respiratory parameters in the two groups

Parameters	MV group (n = 75)	PCV group (n = 76)	95% CI for differences	*P*-value
Occurrence of GI	36 (48.0%)	9 (11.8%)		0.000
Baseline gastric antrum area (cm^2)	1.0 (0.4)	0.9 (0.4)	−0.03 to 0.21	0.145
Post-ventilation gastric antrum area (cm^2)	1.3 (0.6)	1.0 (0.5)	0.13 to 0.46	0.001
Detection method (US/auscultation/both)	12/9/16	7/1/1		0.045
During facemask ventilation				



What this article adds

- The incidence of gastric insufflation can be reduced and peak airway pressure is more stable and consistent with pressure-controlled ventilation than with manual ventilation performed at an inspiratory pressure of 13 cm H_2O during facemask ventilation in paralyzed children.

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

British Journal of Anaesthesia, 122 (5): 682–691 (2019)

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,*]

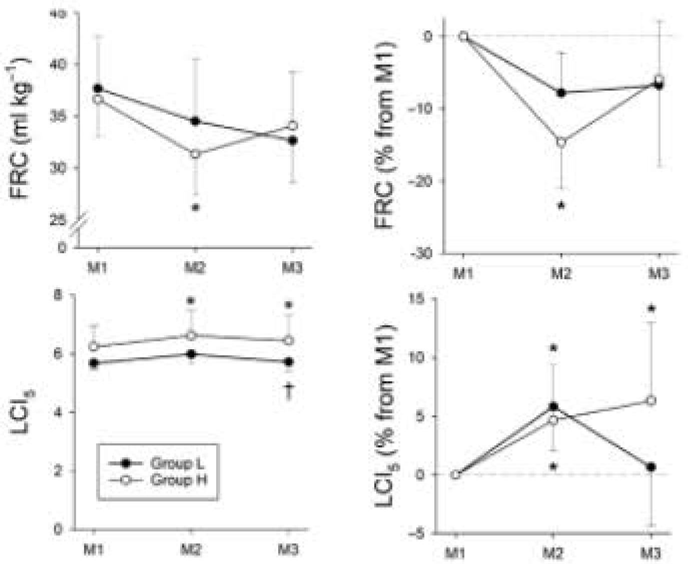


Fig 2. Lung volume and heterogeneity indices. Lung volume and heterogeneity indices were obtained by the multiple-breath nitrogen washout (MBW) technique in the children allocated to receive FiO_2 80% (FiO_2>0.8; open circles) or FiO_2 35% (FiO_2 [0.8→0.35] group; closed circles) during anaesthesia maintenance. M1, M2, and M3 are the three measurement time points, respectively, before operation, after operation upon transfer to the ward, and at Postoperative day 1. Symbols and error bars: mean and 95% confidence interval. *P<0.05 vs M1 within a group. †P<0.05 between FiO_2 (0.8→0.35) group and FiO_2>0.8 group, at each time point. FRC, functional residual capacity; LCI, lung clearance index.

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

Pediatric Anesthesia. 2021;31:1276–1281.

	60% oxygen (n = 17)	80% oxygen (n = 18)	100% oxygen (n = 17)
Sex (male/female)	12/5	15/3	12/5
Age (years)	1.4 ± 0.4	1.6 ± 0.8	1.8 ± 0.9
Height (cm)	80.0 ± 6.6	81.9 ± 9.6	85.9 ± 8.3
Weight (kg)	10.3 ± 1.9	10.5 ± 1.8	11.5 ± 2.0
Tidal volume (mL)†	90.0 (75.0–110.0)	100.0 (64.0–120.0)	95.0 (81.3–117.5)
Respiration rate (min)	22.8 ± 3.2	22.0 ± 1.9	22.4 ± 2.0
Peak airway pressure	17.1 ± 3.4	16.9 ± 2.8	15.2 ± 3.1
End-tidal CO_2†	35.4 (34.3–38.0)	36.0 (33.8–39.5)	35.8 (34.5–37.5)
Oxygen administration	5.6 ± 0.5	5.5 ± 0.7	5.6 ± 0.6
Operation duration (min)†	47.0 (30.3–55.8)	54.0 (31.0–76.0)	52.5 (31.0–76.5)

Note: Data are presented as the medians (interquartile range)† or means ± standard deviation.

	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

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).

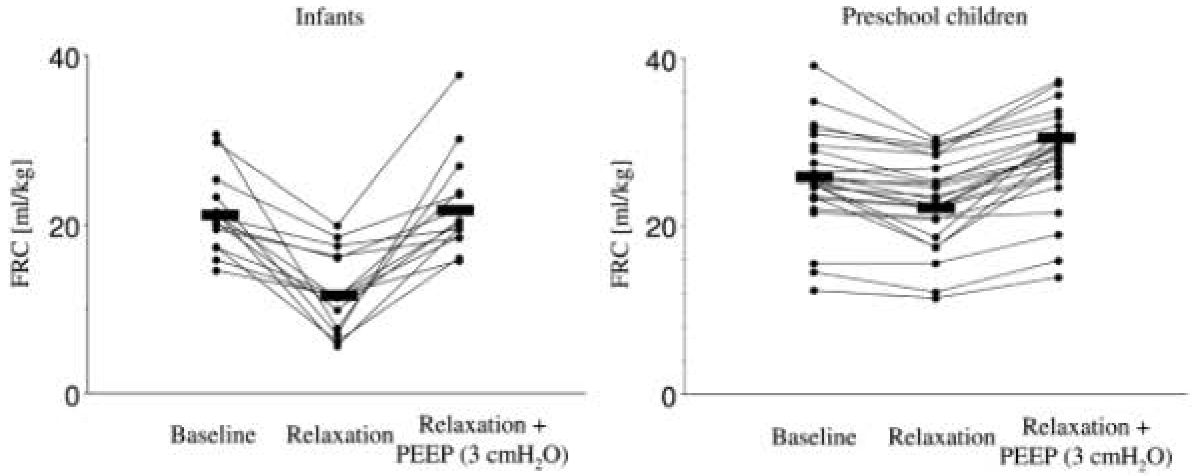
Conclusion: Lower oxygen concentration during anesthetic induction is associated with less atelectasis formation immediately after anesthetic induction in children. In addition, applying 80% oxygen instead of 100% oxygen is not enough to prevent atelectasis formation, and 60% oxygen should be applied to prevent atelectasis. However, this effect does not last until the end of surgery.

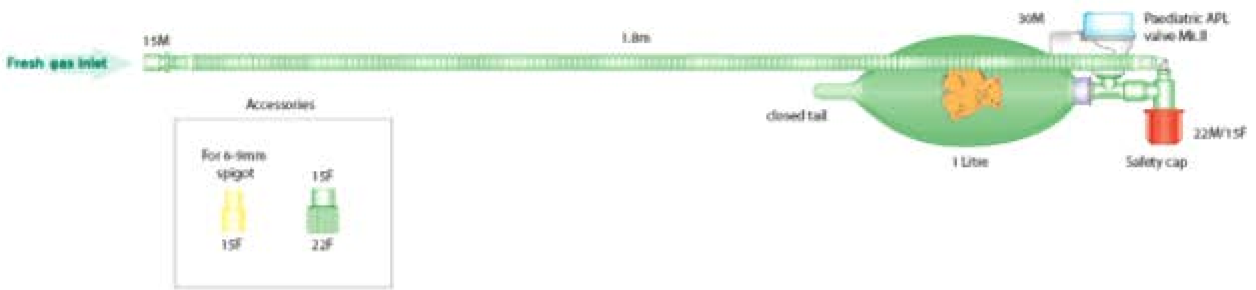
Decrease of Functional Residual Capacity and Ventilation Homogeneity after Neuromuscular Blockade in Anesthetized Young Infants and Preschool Children

Anesthesiology 2006; 105:670–5

Britta S. von Ungern-Sternberg, M.D.,* Jürg Hammer, M.D.,† Andreas Schibler, M.D.,‡
Franz J. Frei, M.D.,§ Thomas O. Erb, M.D.‖

Fig. 1. Functional residual capacity (FRC, ml/kg) after induction of anesthesia (baseline), during neuromuscular blockade, and during neuromuscular blockade plus additional application of 3 cm H_2O positive end-expiratory pressure (PEEP) in young infants and preschool children. *Bars* indicate the mean values.




Fresh gas inlet
15M
1.8m
30M
Paediatric APL
valve Mk.II
closed tail
1 Litre
22M/15F
Safety cap
Accessories
For 6-9mm
spigot
15F
15F
22F

?

He guy…. please help me when I fall asleep……

- Don't leave your baby breathing spntaneously when he loses his airway
- **Apply gentle PSV and Peep to compensate:**
    - Change in FRc
    - Mimic the nasal breathing « auto peep »
    - Atelectalis occurs very early and pulmonary lesion occur when inhomogeneity appears…
    - **AVOID high FiO2**
    - Empty the stomach ….. As soon as possible

Protective ventilation

- Avoid:
  - volotrauma ++++
  - Barotrauma
  - « **Atelectrauma** »

- **A lot has been retrieved from the adult experience ……. However, this has not been studied clearly in children and is still discussed**
- **However, physiological TV is 6 ml /kg**

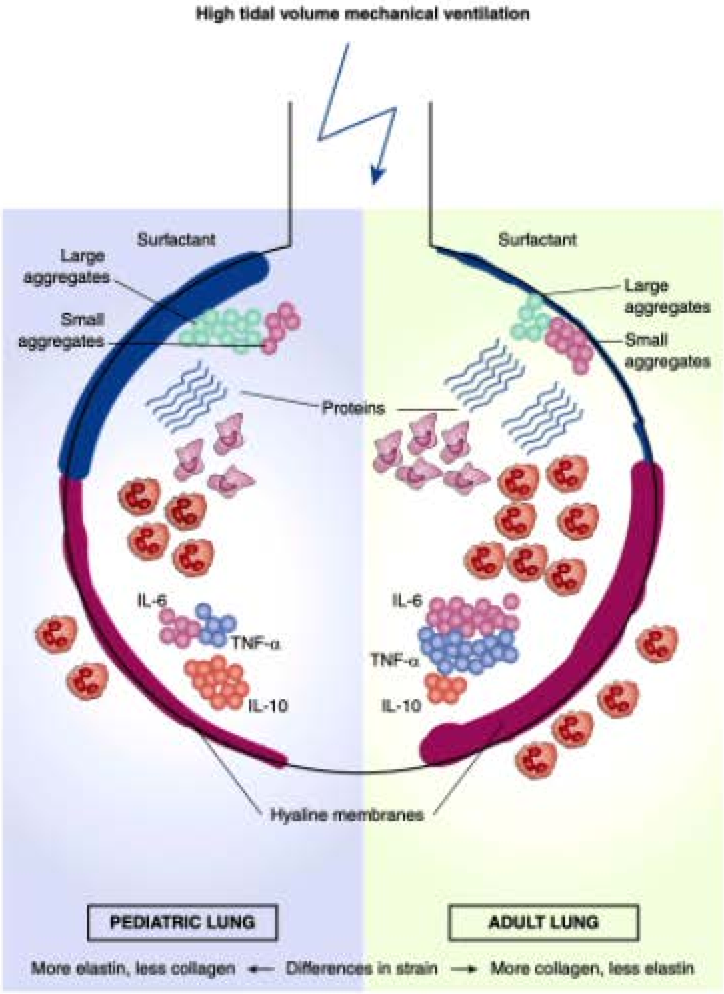
Ventilator-induced Lung Injury

Similarity and Differences between Children and Adults

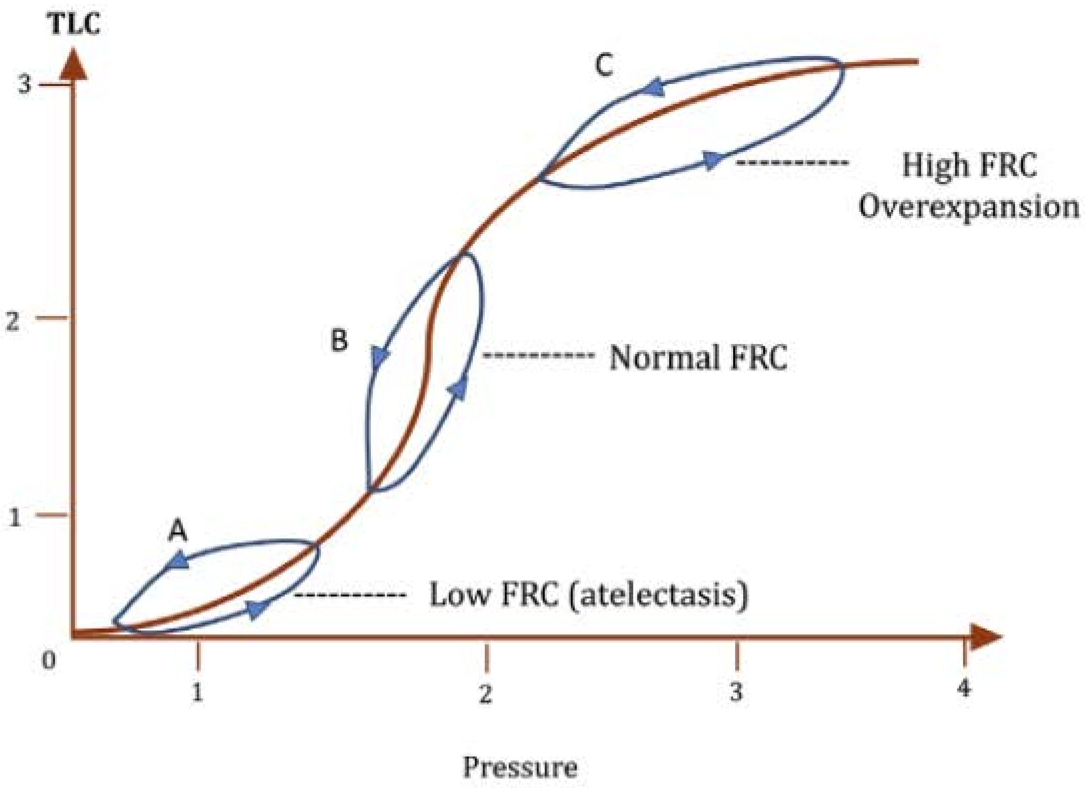
Martin C. J. Kneyber[1,2,3], Haibo Zhang[1,4,5,6], and Arthur S. Slutsky[1,5]

American Journal of Respiratory and Critical Care Medicine Volume 190 Number 3 | August 1 2014

What This Study Adds to the Field: There is a lack of data from randomized, controlled clinical trials addressing the relevance of VILI in pediatric patients with acute respiratory distress syndrome. Observational data from the pediatric population are insufficient to answer the question about the relevance of VILI to children. Experimental data demonstrate an age-related susceptibility to VILI, although the pathophysiological mechanisms are not completely understood. One factor may be the difference in the immune response after mechanical ventilation–induced stretch.

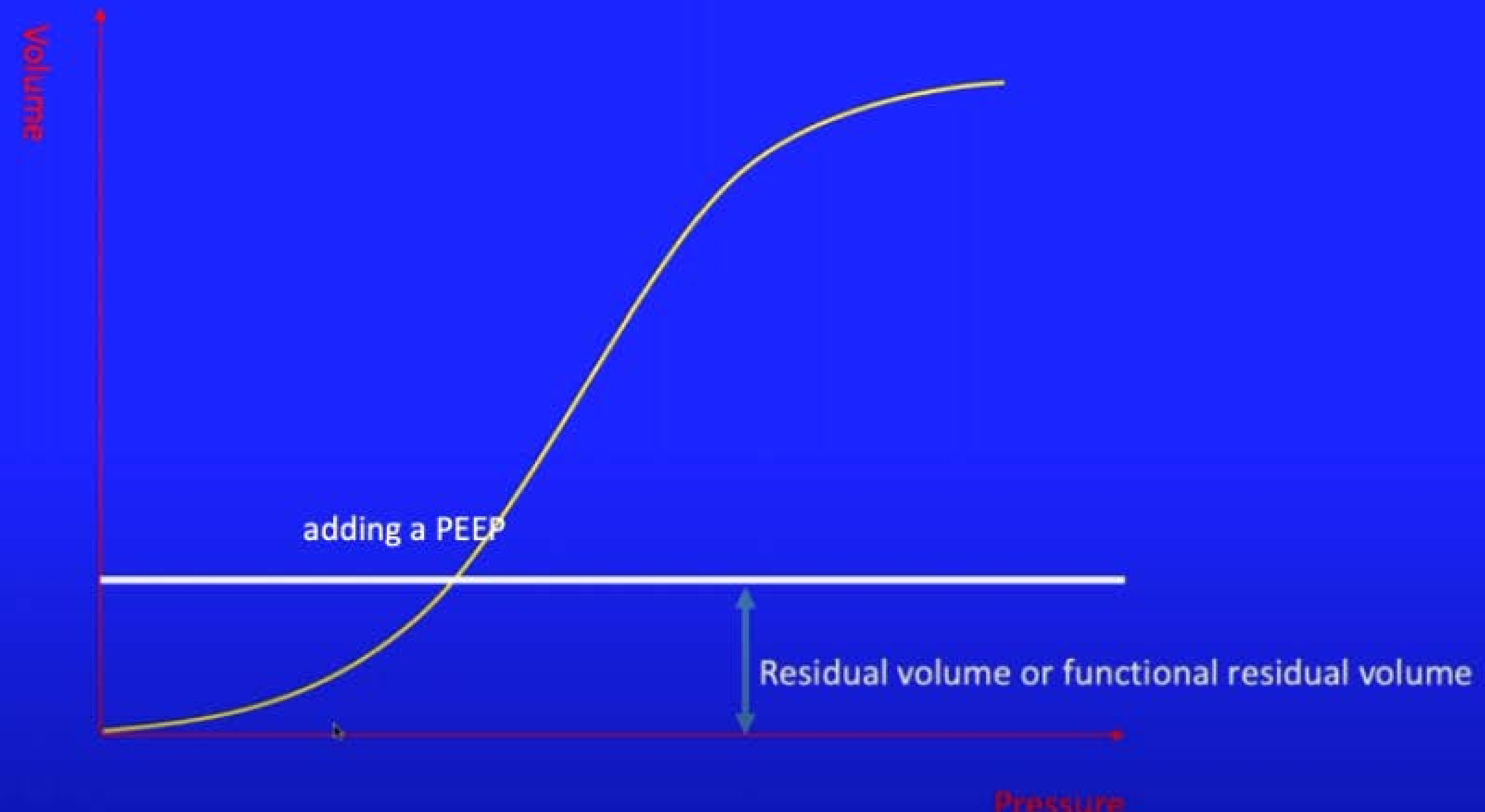


ure 1. This simplified illustration of an alveolus summarizes the differences in ventilator-induced



TLC
3
2
1
0
A
B
C
High FRC
Overexpansion
Normal FRC
Low FRC (atelectasis)
1
2
3
4
Pressure

PEEP



Volume
adding a PEEP
Residual volume or functional residual volume
Pressure

Decrease of Functional Residual Capacity and Ventilation Homogeneity after Neuromuscular Blockade in Anesthetized Young Infants and Preschool Children

Anesthesiology 2006; 105:670–5

Britta S. von Ungern-Sternberg, M.D.,* Jürg Hammer, M.D.,† Andreas Schibler, M.D.,‡
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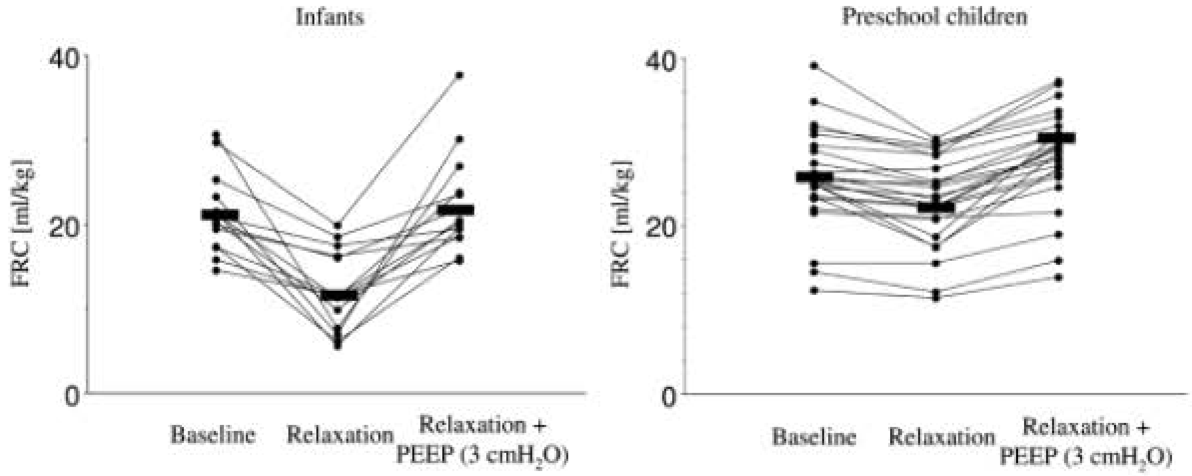


Positive end-expiratory pressure improves elastic working pressure in anesthetized children

Cruces *et al. BMC Anesthesiology* (2018) 18:151

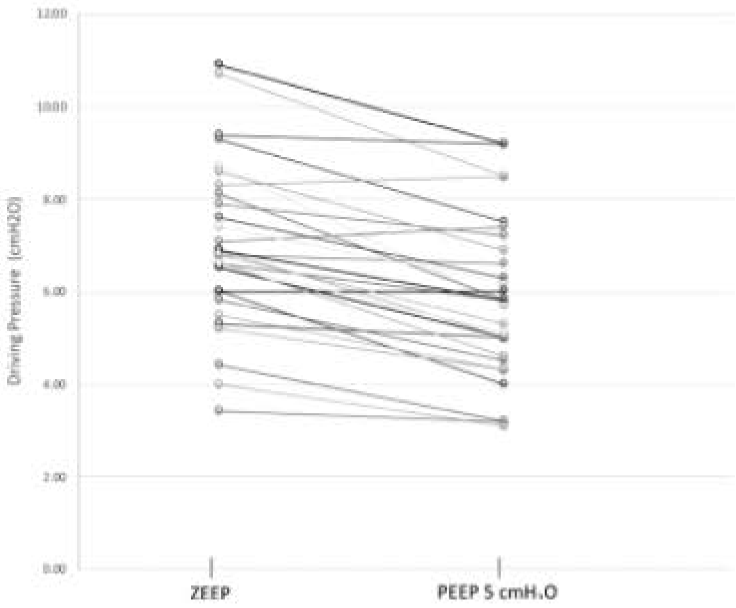


Table 2 Ventilatory parameters and respiratory system mechanics of children under general anesthesia with ZEEP and PEEP of 5 cmH_2O

	ZEEP (*n* = 30)		PEEP 5 (*n* = 30)		*P* value
	MEDIAN	P25, P75	MEDIAN	P25, P75	
FiO_2	0.40	0.36, 0.50	0.40	0.36, 0.50	1.000
V_{TE}	6.79	6.18, 7.36	6.53	5.97, 7.20	0.290
RR	24	21, 26	24	21, 26	1.0
IT	0.85	0.72, 1.02	0.85	0.72, 1.03	1.00
PIP	12	11, 14	15.5	14.0, 18.5	< 0.01
P_{PL}	7.9	7.2, 9.18	10.95	9.7, 12.6	< 0.01
Paw	4.1	3.6, 4.9	8.5	7.9, 9.8	< 0.01
Q_I	11	8.1, 13.1	11	8.1, 13.1	0.317
Q_E	13.8	11.8, 13.1	11.7	9.1, 13.5	< 0.01
RawI	25.7	18.6, 34.3	26.4	20.1, 33.1	0.447
RawE	28.9	21.9, 39.4	29.3	22.3, 42.1	0.629
C_{RS}	0.96	0.89, 1.22	1.19	0.94, 1.39	< 0.01
K_{TI}	0.36	0.31, 0.48	0.45	0.38, 0.59	0.004

Determining optimal positive end-expiratory pressure and tidal volume in children by intratidal compliance: a prospective observational study

British Journal of Anaesthesia, 128 (1): 214–221 (2022)

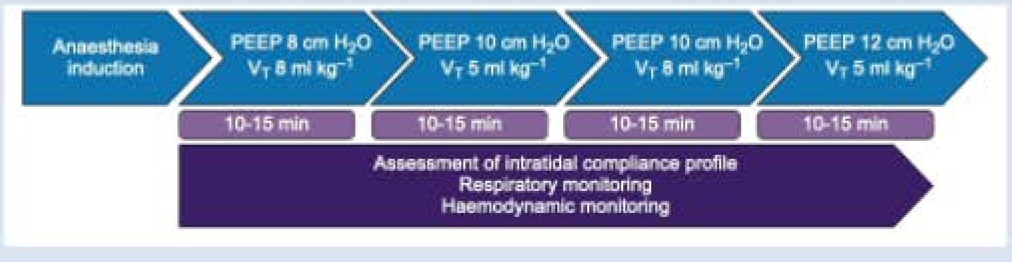
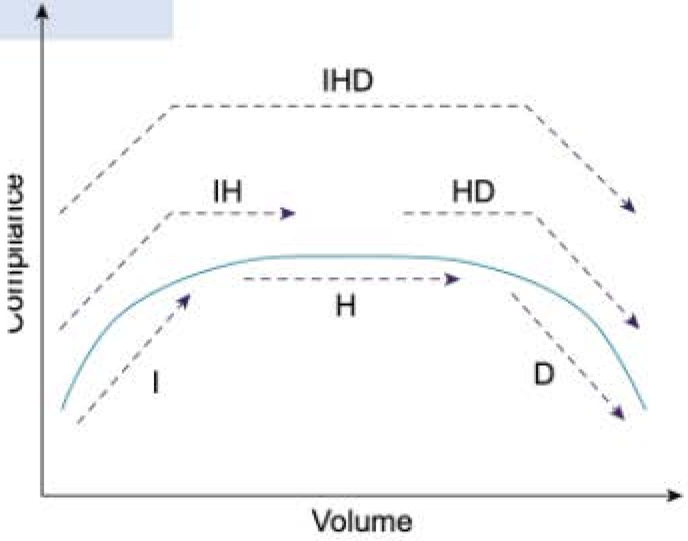
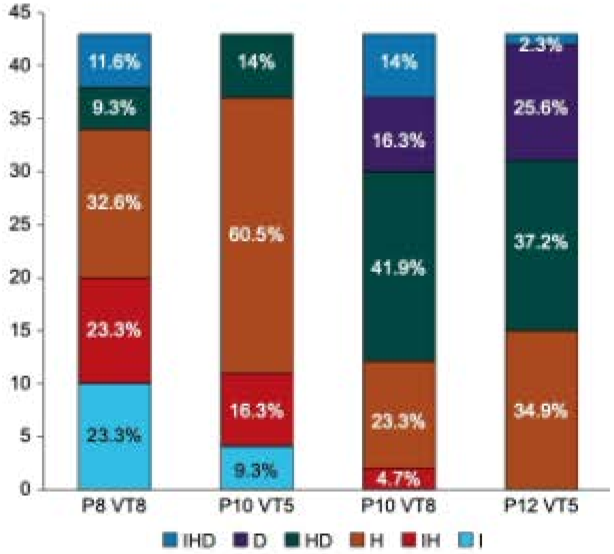


Fig 1. Study flowchart. V_T, tidal volume.



Optimal alveolar ventilation (horizontal [H] profile) was achieved in 14 (32.6%), 26 (60.5%), 10 (23.3%), and 15 (34.9%) children at PEEP8/VT8, PEEP10/VT 5, PEEP10/VT8, and PEEP12/VT5, respectively (Fig. 3).



- V_T 5 ml kg^{-1} combined with 10 cm H_2O PEEP may reduce atelectasis and overdistension, and minimise driving pressure in most mechanically ventilated children <6 yr; any impact on postoperative pulmonary complications requires further study.

Fig 3. Distribution of the compliance profiles according to the ventilator settings. D, merely decreasing compliance profile; H, horizontal compliance profile; HD, horizontal turning into decreasing compliance profile; I, merely increasing compliance profile; IH, increasing turning into horizontal compliance profile; IHD, increasing turning into horizontal and further turning into decreasing compliance profile.

Children Ventilation = PEEP

Specially at low tidal volume

Anesthesiology 2003; 98:14–22

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 Garcia, M.D.,‡ Elsio Turchetto, M.D.,§ Paul G. H. Mulder, M.S., Ph.D.,|| Burkhard Lachmann, M.D., Ph.D.#

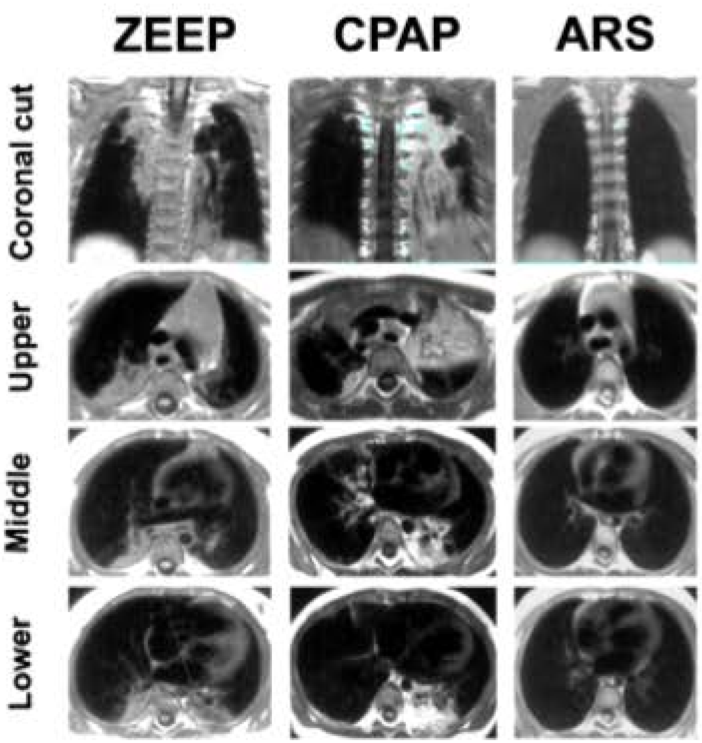


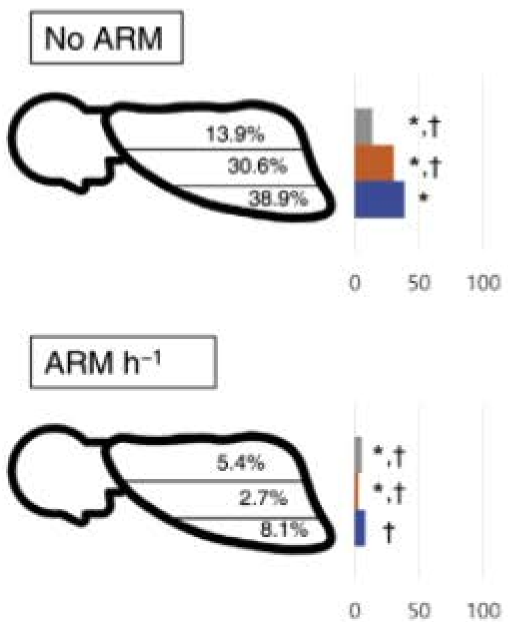
Fig. 3. Nuclear magnetic resonance images of representative patients for each of the three treatment groups. (*Left*) ZEEP = zero end-expiratory pressure; (*middle*) PEEP = positive end-expiratory pressure of 5 cm H_2O; (*right*) ARS = alveolar recruitment strategy with images taken at a PEEP of 5 cm 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.

Table 2. Atelectatic Volumes

	ZEEP	CPAP	ARS
Atelectasis volume (cm^3)			
Right	1.25 (0.75–4.56)*	9.5 (3.1–23.7)	0†‡
Left	4.25 (3.2–13.9)	8.8 (5.3–28.5)	0†‡

Effect of regular alveolar recruitment on intraoperative atelectasis in paediatric patients ventilated in the prone position: a randomised controlled trial

British Journal of Anaesthesia, 124 (5): 648–655 (2020)



Pre-extubation		
Significant atelectasis (consolidation score ≥2)	17 (47.2)	3 (8.1)
Total consolidation score	4.0 (1.0–9.0) [0–16]	3.0 (1.0–4.5) [0–16]
Total B-line score	8.6 (5.6)	7.6 (4.3)

In conclusion, infants and children are vulnerable to atelectasis during general anaesthesia in the prone position. Regular recruitment effectively prevented significant atelectasis at the end of surgery in the prone position and oxygen desaturation during emergence in infants and children <3 yr of age, whereas a single early alveolar recruitment manoeuvre combined with PEEP of 7 cm H_2O failed to prevent atelectasis.

Ventilating the Lungs Safely: What's New for Infants and Children?

Regula Corbelli · Walid Habre

Curr Anesthesiol Rep (2013) 3:42–48
DOI 10.1007/s40140-012-0008-z

PEDIATRIC ANESTHESIA (J LERMAN, SECTION EDITOR)

Ventilating with a low tidal volume cannot be considered without considering the open-lung strategy, which protects from the shear stress alveolar injury induced by repetitive opening and closure of closed alveolar units.

However, alveolar recruitment may be harmful and should only be considered when facing a loss in lung volume. This approach is associated with the application of optimal PEEP, which should coincide with the best lung compliance.

Is there any better mode of ventilation for children????

CME **Optimal Ventilation of the Anesthetized Pediatric Patient**

(Anesth Analg 2015;120:165–75)

Jeffrey M. Feldman, MD, MSE

- Pressure controlled ventilation: PCV

- Lung recruitment
- Slower increase in pressure
- Subject to variation in compliance

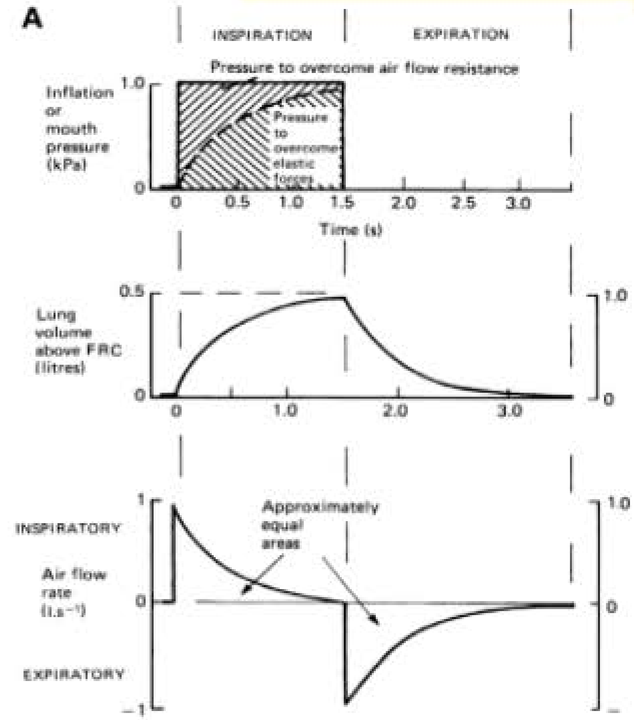


Figure 3A. Pressure, volume, and flow waveforms during pressure-controlled ventilation (PCV). Constant pressure in PCV is determined by the set pressure and inspiratory time. So-called decelerating flow waveform results as less flow is needed to maintain the set pressure as the lung fills with gas. Note that the portion of the pressure time curve available to overcome the elastic forces of the lung is much greater than the portion overcoming resistance. The same waveforms will be seen when using "best-of-both-ventilation," although in that case, the ventilator determines the inspiratory pressure based on the set tidal volume and the patient's lung compliance. (From Lumb AB, Nunn's Respiratory Physiology, 5th Edition, Butterworth-Heinemann Pub., Woburn, MA, 2000.)

Impact of Targeted-Volume Ventilation on Lung Inflammatory Response in Preterm Infants With Respiratory Distress Syndrome (RDS)

Pediatric Pulmonology 37:510–514 (2004)

G. Lista, MD,[1*] M. Colnaghi, MD,[2] F. Castoldi, MD,[1] V. Condò, MD,[2] R. Reali, MD,[3]
G. Compagnoni, MD,[1] and F. Mosca, MD[2]

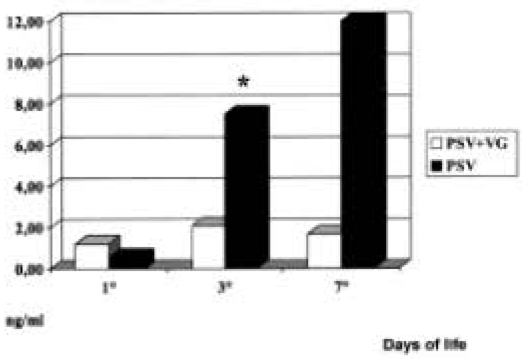


Fig. 1. Tracheal IL-8 (values expressed as medians). $^{*}P < 0.05$, PSV vs. PSV + VG group.

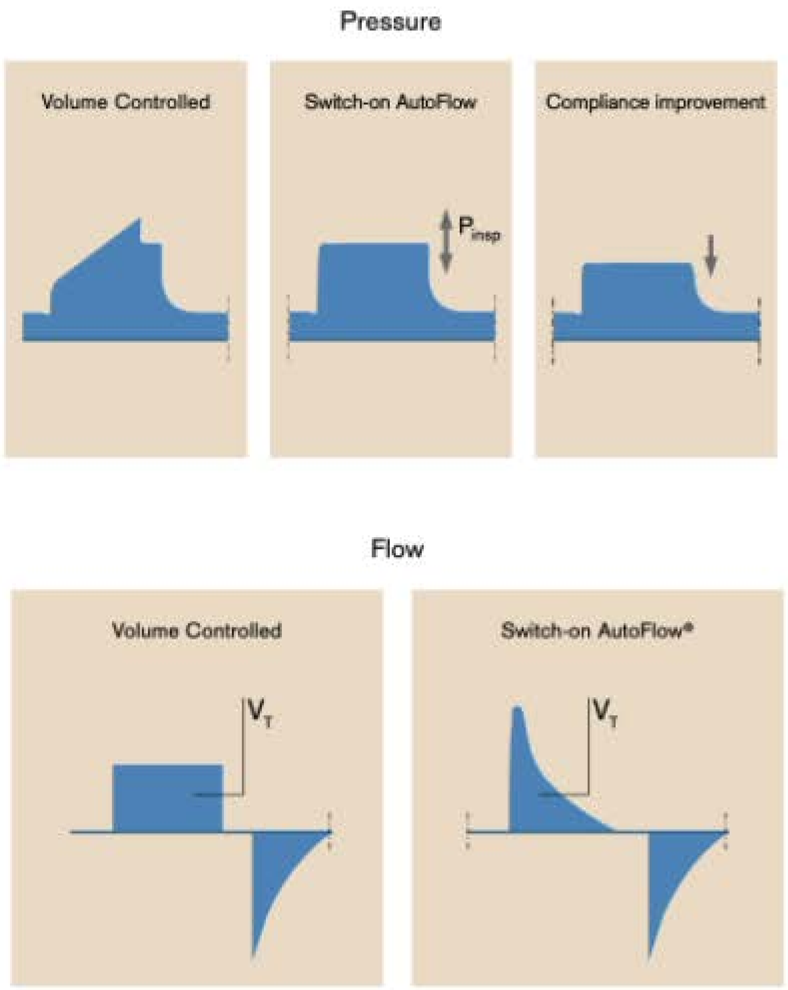
TABLE 2—Respiratory and Ventilatory Parameters on Day 3 in PSV + VG and PSV Groups (Values Expressed as Means ± SD)

	PSV + VG (n = 30)	PSV (n = 23)
Vt (ml/kg)	5 ± 0.3	5 ± 1.35
PIP (cmH_2O)	15.5 ± 4.4	$18 \pm 4.2^{*}$
PEEP (cmH_2O)	3.9 ± 0.1	3.8 ± 0.2
MAP (cmH_2O)	5.6 ± 1.4	$7.3 \pm 1.6^{*}$
C20/C	1.8 ± 0.82	1.7 ± 0.63
PaO_2 (mmHg)	61.7 ± 16.6	53.8 ± 14.7
$PaCO_2$ (mmHg)	42.6 ± 11.4	47.3 ± 10.57
FiO_2	0.4 ± 0.1	0.4 ± 0.13

$^{*}P < 0.05$, PSV + VG vs. PSV.

The ideal combination ??? PCV VG.....

- AutoFlow is an adjunct to volume controlled ventilation mode, it automatically regulates inspiratory flow and inspiratory pressure. When AutoFlow is activated the inspiratory flow pattern changes from the constant flow typical of volume controlled ventilation to a decelerating flow pattern usually associated with pressure controlled ventilation.



PCV VG principle

Update on ventilatory management of extremely preterm infants—A Neonatal Intensive Care Unit perspective

Sven M. Schulzke[1,2] | Benjamin Stoecklin[1]

Pediatric Anesthesia. 2021;00:1–9.

Principle of volume-targeted ventilation

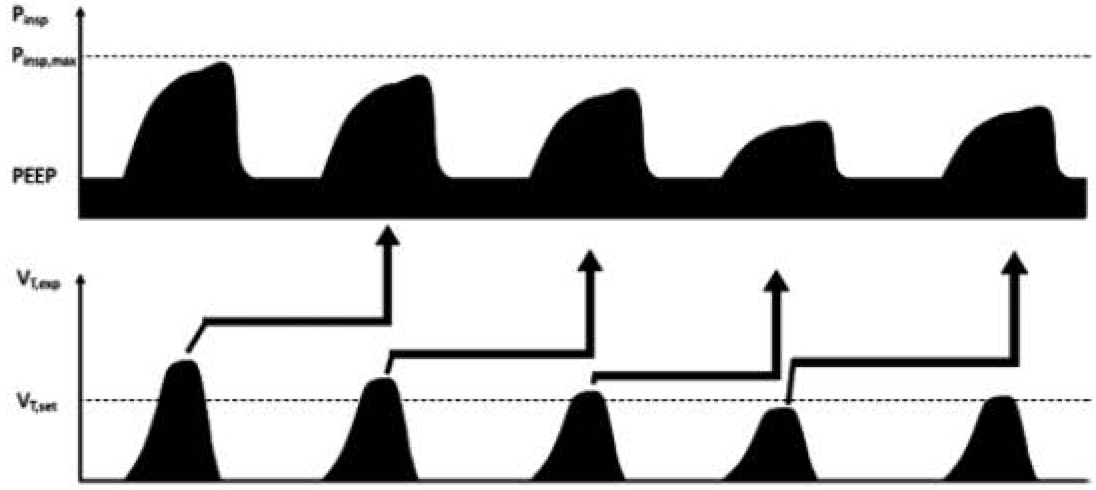


FIGURE 1 The ventilator consecutively reduces inspiratory pressure (P_{insp}) from breath No 1 to breath No 4 with subsequently decreasing expiratory tidal volume ($V_{T,exp}$). P_{insp} is always below preset maximum allowable inspiratory pressure ($P_{insp,max}$). Upon breath No 5, the ventilator slightly increases P_{insp} because the previous $V_{T,exp}$ was below the set target tidal volume ($V_{T,set}$) and $V_{T,exp}$ increases to a value just above $V_{T,set}$. Typically, volume-targeted ventilation does not deploy a fixed, constant tidal volume as in volume-controlled ventilation. $V_{T,exp}$ rather undulates around $V_{T,set}$ using automatically adjusted inspiratory pressures above positive end-expiratory pressure (PEEP)

The Incidence and Severity of Hypocarbia in Neonates Undergoing General Anesthesia

RESPIRATORY CARE • AUGUST 2020 VOL 65 NO 8

Kristin Chenault, Mayuko Wakimoto, Rebecca Miller, and Joseph D Tobias

Thirty-seven subjects (33%) had at least one ABG value that demonstrated hyperventilation (P_{aCO2}<35 mm Hg). Thirteen (12%) were noted to have significant hyperventilation (P_{aCO2} <30 mm Hg) and 2 had extreme hyperventilation (P_{aCO2} <25 mm Hg), both with gestational ages of 38 weeks and postnatal ages of 48 and 49 weeks.

What this paper contributes to our knowledge

In this single-center retrospective observational study, the incidence of intraoperative hyperventilation ($P_{aCO_2} \leq 35$ mm Hg) was high. The subjects who had a lower body weight were more likely to have significant hyperventilation. Given the retrospective nature of the study, no impact on clinical outcome could be attributed to these findings. Although it is unknown if limited periods of hyperventilation are detrimental, further evaluation of intraoperative ventilation strategies and CO_2 monitoring for this population is warranted.

Hypocarbia and Adverse Outcome in Neonatal Hypoxic-Ischemic Encephalopathy

THE JOURNAL OF PEDIATRICS
Vol. 158, No. 5 • May 2011

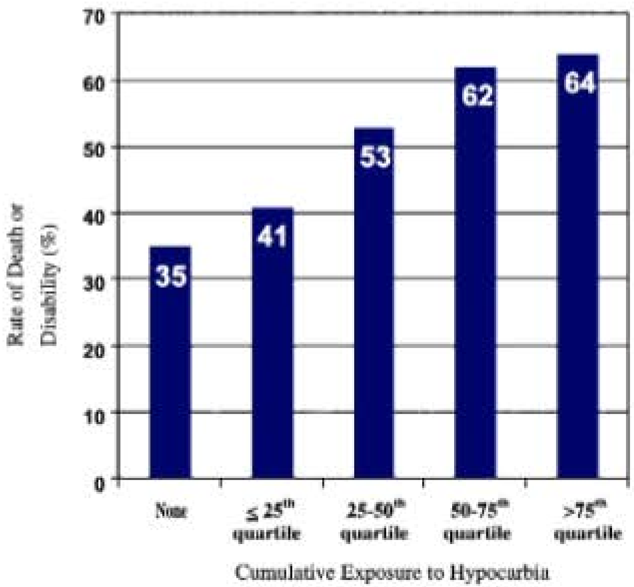


Figure. Rate of primary outcome with increasing cumulative exposure to hypocarbia (PCO_2 <35 mm Hg).

Episodes of hypocarbia and early-onset sepsis are risk factors for cystic periventricular leukomalacia in the preterm infant

Early Human Development 88 (2012) 27–31

Table 3
Neonatal risk factors of 47 preterm infants with cystic periventricular leukomalacia (PVL) compared to 94 controls matched for year of birth, gestational age, birth weight, and gender, between 1999 and 2008: univariate analysis.

Risk factor	PVL n = 47	Controls n = 94	p value
Asphyxia	4 (8.5)	9 (9.6)	.434
Apnoeas	30 (64)	55 (59)	.297
Arterial hypotension	11 (23)	25 (27)	.394
Hyperbilirubinaemia[a]	17 (36)	27 (29)	.164
Neonatal seizures	4 (8.5)	1 (1.1)	.011
Early-onset sepsis	11 (23)	10 (11)	.024
Neonatal antibiotics	33 (70)	65 (69)	.485
Neonatal steroids	10 (21)	9 (9.6)	.020
IVH I-III	13 (28)	17 (18)	.096
PDA[a]	12 (26)	29 (31)	.269
RDS	34 (72)	51 (54)	.013
Respiratory support[b]	37 (79)	65 (69)	.080
Days on respiratory support[b]	12.8 ± 15.4 (0–66)	9.4 ± 13.6 (0–69)	.090
Hypocarbia[c]	21/31 (68)	22/62 (35)	<.002

1.c PaCO2 b< 35 mm Hg (b 4.67 kPa) within the first 5 days of life

Arterial to End-Tidal Carbon Dioxide Tension Differences in Infants and Children

Brigitte Ickx*, Jacques-Olivier Dolomie, Mariame Benalouch, Christian Melot and Pierre Lingier

In conclusion, in pediatric patients weighing less than 5 kg or under 4 months who are mechanically ventilated via an endotracheal tube, $ETCO_2$ is useful for a trend monitor but is not an accurate indicator of $PaCO_2$. Even if $ETCO_2$ is mandatory to indicate the correct position of an endotracheal tube, caution should be used when utilizing capnometry to evaluate the adequacy of ventilation in very small patients.

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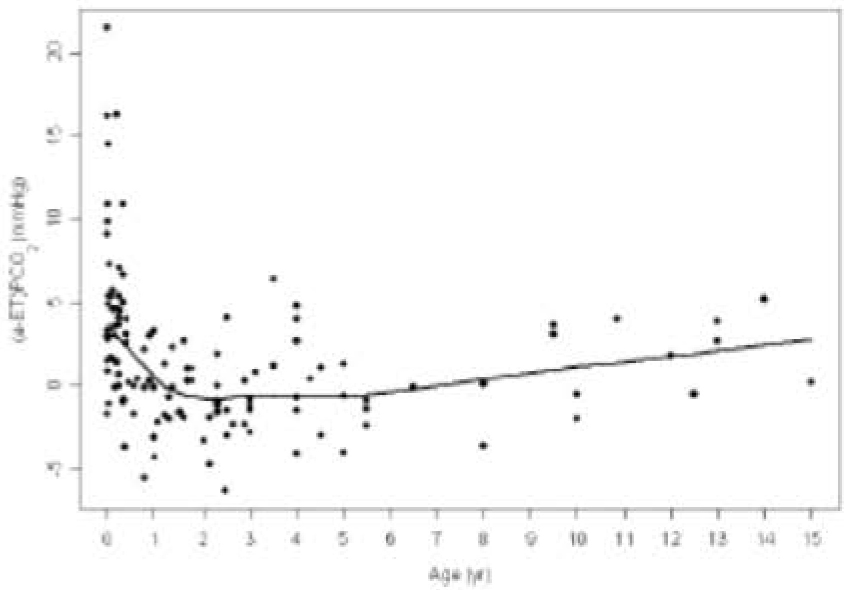

Arterial to end-tidal carbon dioxide difference in children undergoing mechanical ventilation of the lungs during general anaesthesia

Anaesthesia 2017, 72, 1357-1364

C. Onodi,[1] P. K. Bühler,[1] J. Thomas,[2] A. Schmitz[3] and M. Weiss[4]

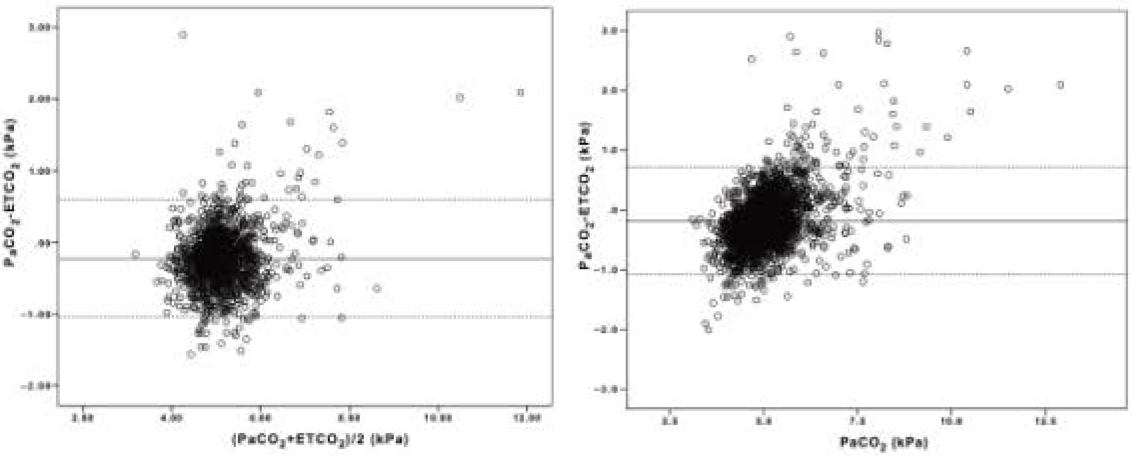

Figure 2 Classical (left) and modified (right) Bland Altman bias diagrams for the comparison of arterial ($PaCO_2$) (pHstat) and end-tidal ($ETCO_2$) carbon dioxide values (n = 799/2452 data sets).

In conclusion, $ETCO_2$ monitoring in paediatric patients whose lungs are ventilated may paradoxically lead to overestimation of $ETCO_2$ ($ETCO_2 > PaCO_2$) with the risk of hypocarbia and related deleterious effects on cerebral circulation. We encourage prospective studies, initiated by industrial partners, to elucidate predictors so as to improve their equipment. Until then, arterial or capillary blood gas testing should be performed, even during routine paediatric anaesthesia, in order to avoid iatrogenic hypocapnoea and associated peri-operative central nervous system injury to children.

NB: 1kPa= 7,5 mmHG

Awake caudals and epidurals should be used more frequently in neonates and infants

Peter Marhofer[1], Maya Keplinger[1], Wolfgang Klug[1] & Martin L. Metzelder[2]

Pediatric Anesthesia **25** (2015) 93–99

Charmant, C ; Veyckemans, Francis ; Vanobbergh, LJ.. *Caudal block in awake high-risk neonates & infants: Prone versus lateral decubitus position.*

British Journal of Anaesthesia, Vol. 76, p. A313-A313 (1996)

A

Association of anesthesia type with prolonged postoperative intubation in neonates undergoing inguinal hernia repair

Journal of Perinatology (2021) 41:571–576

Abdulraouf Lamoshi[1] · Jerrold Lerman[1,2] · Jad Dughayli[1,2] · Valerie Elberson[3] · Lorin Towle-Miller[4] · Gregory E Wilding[4] · David H Rothstein[1,5]

CA is associated with a substantially decreased need for postoperative tracheal intubation when compared with GA in neonates undergoing inguinal herniorrhaphy. History of prior intubation and/or BPD may jeopardize the postoperative course for neonatal patients after herniorrhaphy by increasing the need for postoperative ventilation support. In addition, using agents that antagonize neuromuscular blockade may reduce the duration of postoperative tracheal intubation.

Take home message

Respiratory events occur frequently in children

VILI occurs when heterogeneity appears !!!!!!!!!!

Therefore avoid atelectasis <u>very early</u>:

- During induction ……. Help your baby….
- During anesthesia
  - Small Tidal volume WITH PEEP and gentle Recruitment
  - Don’t use high FiO2
  - Use PV VG
  - Be aware of “overventilation” in infants
- During awakening
  - Avoid high FiO2
  - Avoid hypoventilation
- Always empty the stomach