4° Congreso Argentino de Neonatología
22, 23 y 24 de mayo de 2019
En el marco de
Semana de Congresos y Jornadas Nacionales 2019
"Por un niño sano en un mundo mejor"
Panamericano Buenos Aires Hotel & Resort – Carlos Pellegrini 551 – Ciudad de Buenos Aires
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Volumen garantizado en ventilación de alta frecuencia

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Potencial conflicto de interés

- Asesor científico
  - Dräger

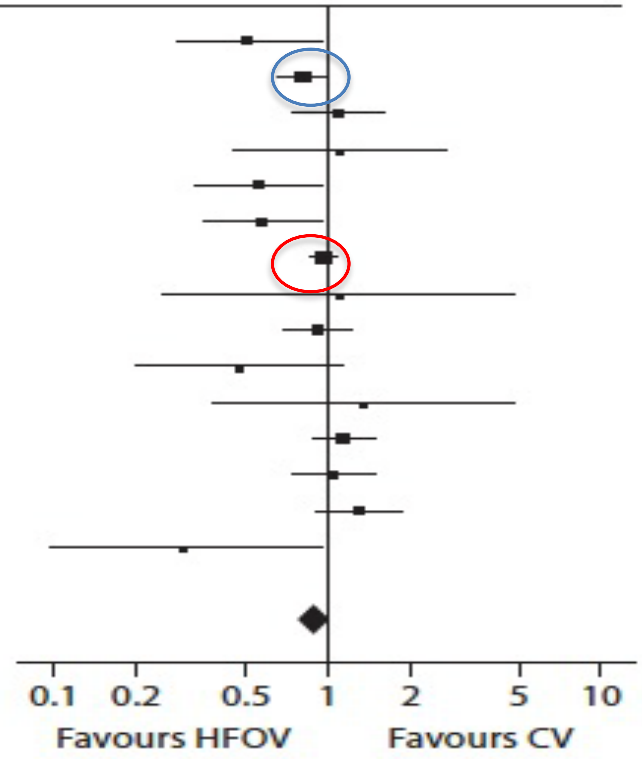
Elective use of HFOV as compared to conventional ventilation (CV)

death or chronic lung disease at 36–37 weeks' postmenstrual age or discharge.

Study or subgroup	HFOV events	HFOV total	CV events	CV total	Weight %	Risk ratio M-H, fixed (95% CI)
Clark, 1992	11	37	16	28	4.2	0.52 (0.29, 0.94)
Courtney, 2002	103	244	133	254	13.7	0.81 (0.67, 0.97)
Craft, 2003	16	22	16	24	7.7	1.09 (0.74, 1.60)
Dani, 2006	6	13	5	12	2.1	1.11 (0.45, 2.70)
Durand, 2001	10	24	18	24	5.0	0.56 (0.33, 0.94)
Gerstmann, 1996	17	64	28	61	5.6	0.58 (0.35, 0.94)
Johnson, 2002	265	400	268	397	16.9	0.98 (0.89, 1.08)
Lista, 2008	3	19	3	21	8	1.11 (0.25, 4.83)
Moriette, 2001	55	139	57	134	10.4	0.93 (0.70, 1.24)
Plavka, 1999	5	21	10	20	2.2	0.48 (0.20, 1.15)
Rettwitz-Volk, 1998	5	46	4	50	1.1	1.36 (0.39, 4.75)
Schreiber, 2003	61	102	55	105	11.8	1.14 (0.90, 1.45)
Thome, 1998	46	140	45	144	8.8	1.05 (0.75, 1.48)
Van Reempts, 2003	49	147	39	153	8.3	1.31 (0.92, 1.86)
Vento, 2005	3	20	10	20	1.4	0.30 (0.10, 0.93)
Total (95% CI)		**1,438**		**1,447**	**100.0**	**0.90 (0.78, 1.03)**
Total events	655		707			

Heterogeneity: $\tau^2 = 0.03$; $\chi^2 = 28.50$, d.f. = 14 (p = 0.01), $I^2 = 51\%$

Test for overall effect: Z = 1.49 (p = 0.14)



Cochrane Review Update Neonatology 2013;103:7–9

The United Kingdom Oscillation Study (UKOS)

- 400 Infants high-frequency oscillatory ventilation
- 397 Infants received conventional ventilation

Outcome	High-Frequency Oscillatory Ventilation	Conventional Ventilation	Relative Risk (95% CI)*
Primary outcome — no./total no. (%)†			
All infants	265/400 (66)	268/397 (68)	0.98 (0.89–1.08)
Dead	100/400 (25)	105/397 (26)	
Alive, with chronic lung disease	165/400 (41)	163/397 (41)	
Alive, without chronic lung disease	135/400 (34)	129/397 (32)	
Infants 23–25 wk of gestational age	130/148 (88)	119/136 (88)	1.00 (0.92–1.10)
Dead	61/148 (41)	60/136 (44)	
Alive, with chronic lung disease	69/148 (47)	59/136 (43)	
Alive, without chronic lung disease	18/148 (12)	17/136 (12)	
Infants 26–28 wk of gestational age	135/252 (54)	149/261 (57)	0.94 (0.80–1.10)
Dead	39/252 (15)	45/261 (17)	
Alive, with chronic lung disease	96/252 (38)	104/261 (40)	
Alive, without chronic lung disease	117/252 (46)	112/261 (43)	

Johnson AH, et al New Engl J Med 2002;347:633–42.

Late Outcomes of a Randomized Trial of High-Frequency Oscillation in Neonates 11-14 years

Result	No. of Participants with Result†	Conventional Ventilation (N=121)	HFOV (N=127)	Adjusted Difference (95% CI)‡	P Value
FEF z score					
FEF_{75}	248	−1.19±0.80	−0.97±0.95	0.23 (0.02 to 0.45)	0.04
FEF_{50}	248	−1.37±0.85	−1.07±0.93	0.30 (0.09 to 0.52)	0.006
FEF_{25}	248	−1.16±0.95	−0.84±0.90	0.29 (0.07 to 0.51)	0.01
$FEF_{25–75}$	231	−1.58±1.05	−1.34±1.09	0.21 (−0.04 to 0.47)	0.10
FEV_1 z score	248	−0.95±1.02	−0.60±1.08	0.35 (0.09 to 0.60)	0.008
FVC z score	248	−0.44±0.89	−0.29±1.05	0.13 (−0.10 to 0.37)	0.27
FEV_1:FVC ratio z score	248	−1.75±1.78	−1.16±1.75	0.58 (0.16 to 0.99)	0.007
PEF — % of predicted	247	80.3±15.0	86.3±15.5	5.85 (2.21 to 9.49)	0.002

Zivanovic S, et al N Engl J Med 2014; 370 (12): 1121-30.

RELATION BETWEEN THE TYPE OF OSCILLATOR AND DEATH OR CHRONIC LUNG DISEASE AMONG INFANTS ASSIGNED TO RECEIVE HIGH-FREQUENCY OSCILLATORY VENTILATION.

OSCILLATOR	INFANTS	ODDS RATIO (95% CONFIDENCE INTERVAL)		
		UNADJUSTED	ADJUSTED FOR MATERNAL BASE-LINE FACTORS	ADJUSTED FOR INFANT BASE-LINE FACTORS
	no./total no.			
Dräger	168/393	1.00		
SLE	187/393	1.03 (0.66–1.59)	1.04 (0.67–1.62)	1.45 (0.87–2.41)
SensorMedics	38/393	4.94 (1.67–14.58)	4.91 (1.66–14.52)	5.39 (1.72–16.92)

Johnson AH, et al New Engl J Med 2002;347:633–42.

Expired Tidal Volumes Measured by Hot-Wire Anemometer During High-Frequency Oscillation in Preterm Infants

Magdalena Zimová-Herknerová, MD and Richard Plavka, MD, PhD*

SensorMedics 3100A ventilator.

The optimal lung-volume strategy (OLVS).

frequency 10–15 Hz,

The pressure amplitude (DP) vibration of the thorax initially, and
Lowest value consistent with normocapnia or mild hypercapnia (PaCO2, 35–50 mmHg)

Pediatr Pulmonol. 2006;41:428–433

Expired Tidal Volumes Measured by Hot-Wire Anemometer During High-Frequency Oscillation in Preterm Infants

Magdalena Zimová-Herknerová, MD and Richard Plavka, MD, PhD*

118 (55%) normocapnic,
median VT,E was 1.67 ml/kg (95% CI, 1.55–1.79)

42 (20%) hypocapnic,
median VT,E was 1.94 ml/kg (95% CI, 1.74–2.14)

54 (25%) hypercapnic
median VT,E was 1.54 ml/kg (95%CI, 1.42–1.66)

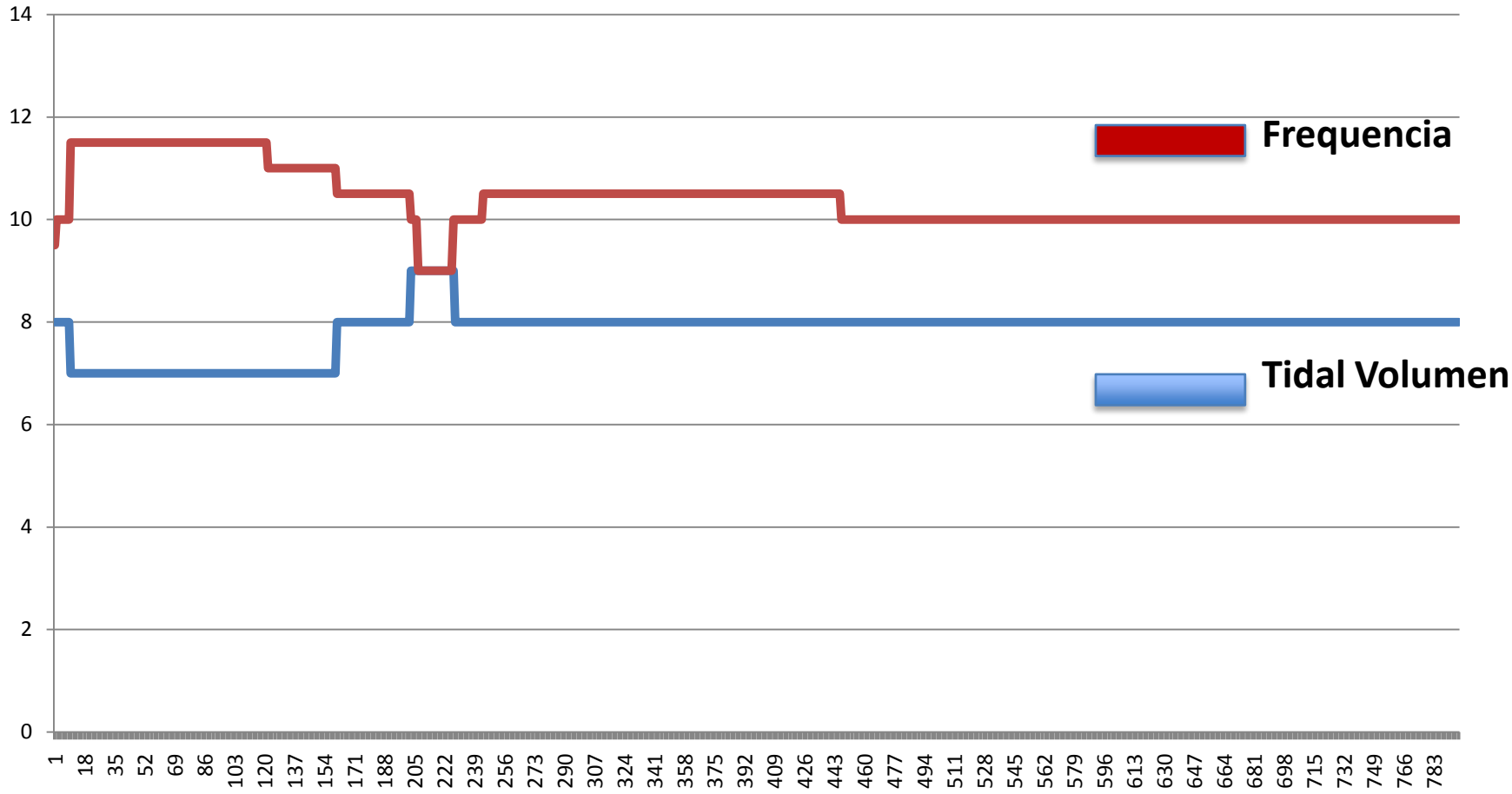
Pediatr Pulmonol. 2006;41:428–433

Ventilación alveolar

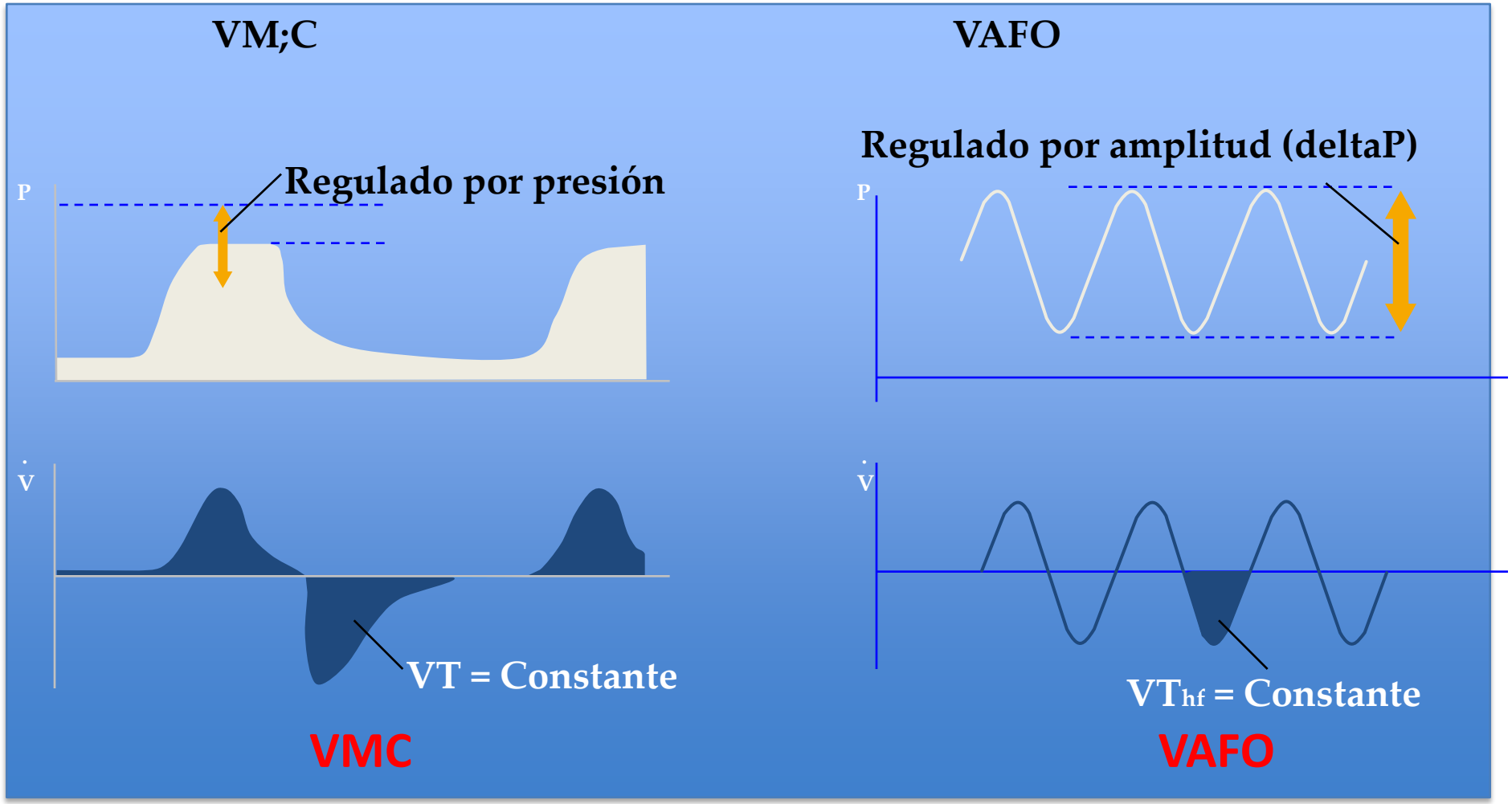
- DCO_2 : Fr x Vt^2
- VAFO es más efectiva en lavar CO2 que VMC

- Tradicionalmente Fr y Vt Hf
- Variables ligadas dependientes
- ¿Podemos independizarlas?

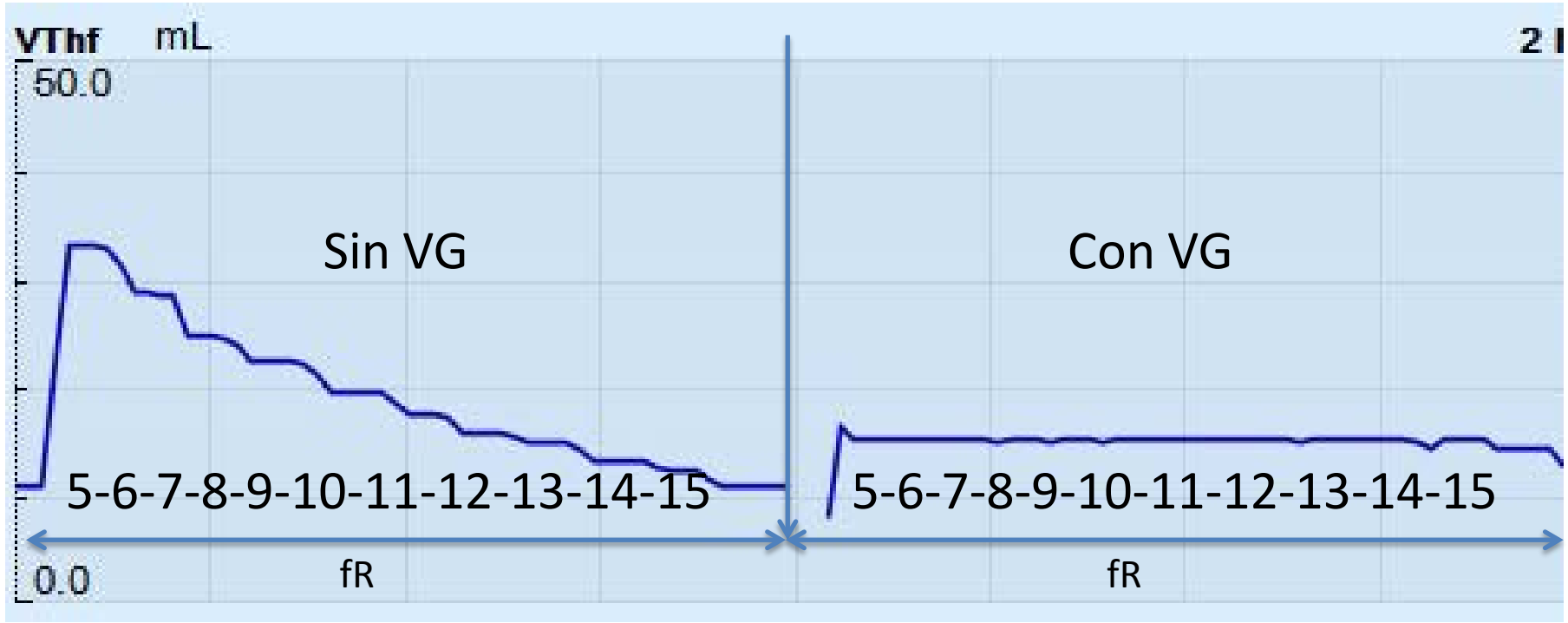
“Clasica” HFOV sin VG
Efecto de la frecuencia sobre el VtHf



VAFO+Volumen Garantizado Dräger



Efecto de la f_R en VtHf



M Sanchez Luna 2013

Preguntas sobre VAFO+VG

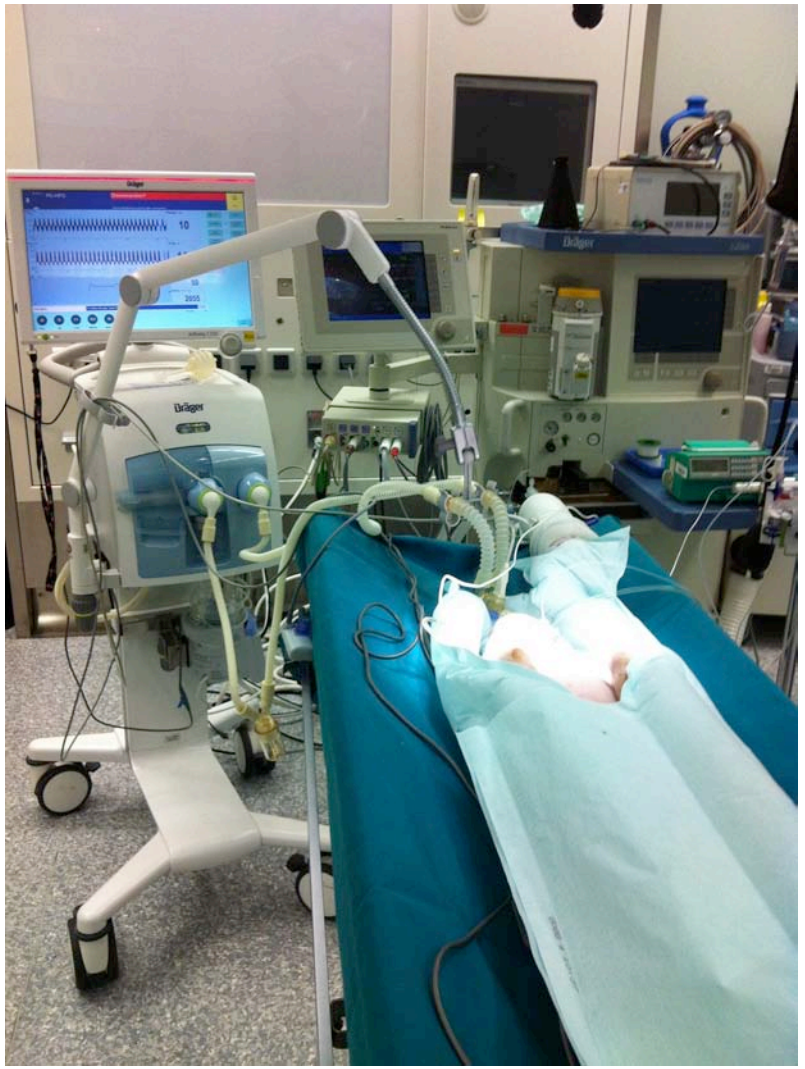
1. Podemos modificar DCO_2 usando solo VtHf?
2. Podemos aumentar DCO_2 aumentando la frecuencia dejando constanteVtHf?
3. Podemos usas frecuencias muy elevadas con DCO_2 similar y disminuir VtHf?
4. Podemos usar esta estrategia en RN?
5. Podemos disminuir el daño pulmonar con esta estrategia?

VAFO+VG
Cambios en VtHf a fR constant de 10 Hz

Dräger VN500

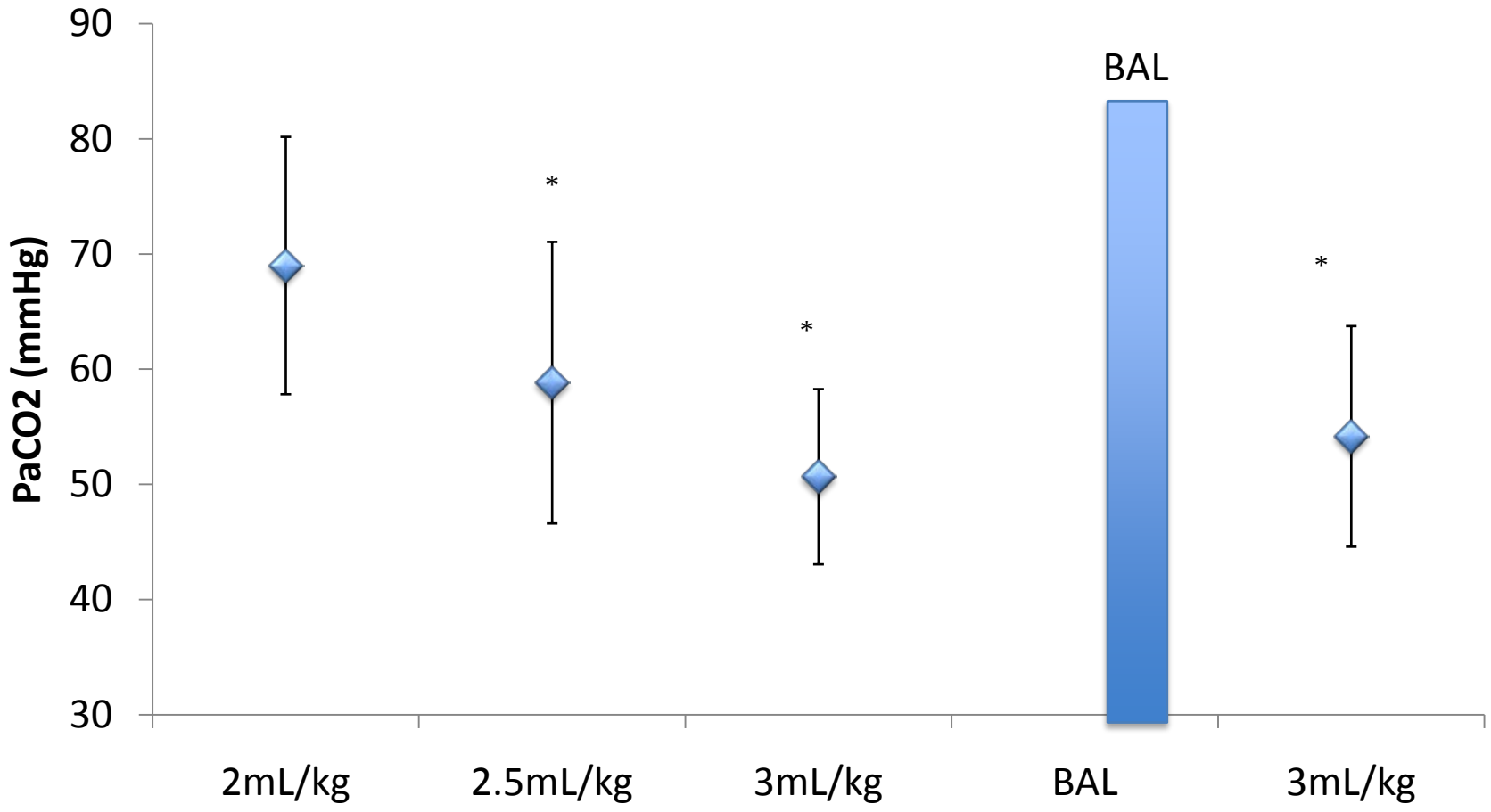
- Lechones RN de 2 días de edad
- Peso 2.57 $\pm$ 0.26 kg
- Pulmón normal
- Pulmón con baja complianza tras BAL

- VAFO +VG



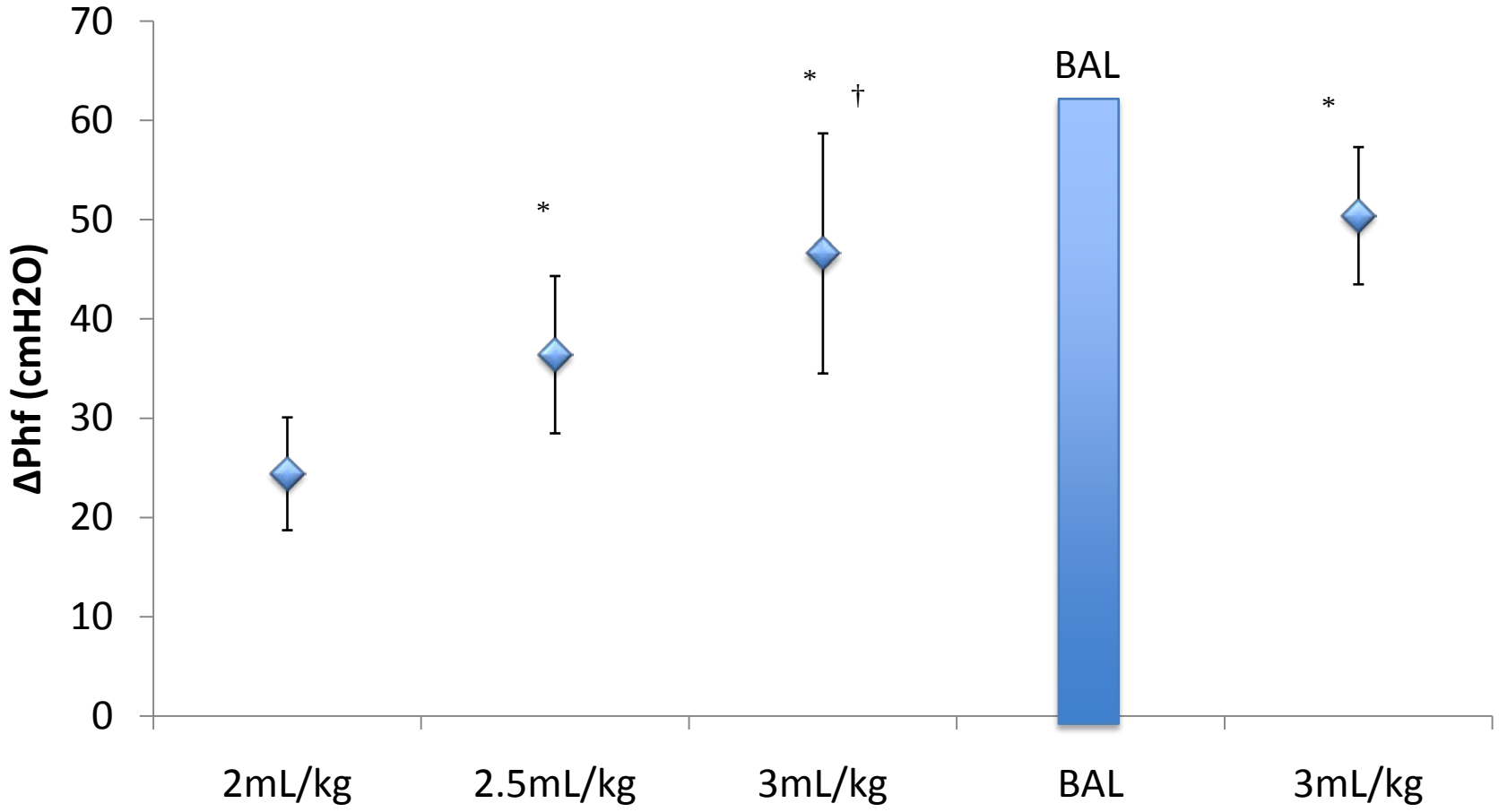
Sanchez Luna M. Crit Care Res Pract 2013

Animal model
HFOV+VG
change in VtHf at a constant fR 10 Hz



Sanchez Luna M et al. Crit Care Res Pract 2013

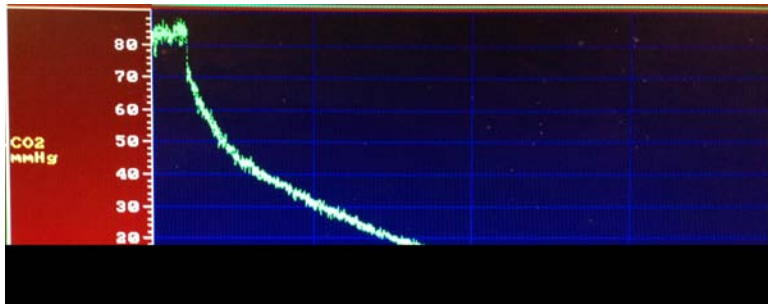
Animal model
HFOV+VG
change in VtHf at a constant fR 10 Hz



Sanchez Luna M et al. Crit Care Res Pract 2013

EFFICACY OF HFOV+VG ON DCO2 AT DIFFERENT FREQUENCIES.
EFFECT ON DELTA PRESSURES

Mukerji A Jaques Belik, Manuel Sanchez-Luna, J Perinatol 2014; 34 (6): 464-7.



Time Seconds 25 50

Measured Variables

- **Initial CO_2**
- **CO_2 25sec**
- **%CO_2 25**
- **CO_2 50 sec**
- **%CO_2 50**
- **Slope**
- **P1 P2 P3**

P 1

P 2

ET CO_2

P 3

CO_2

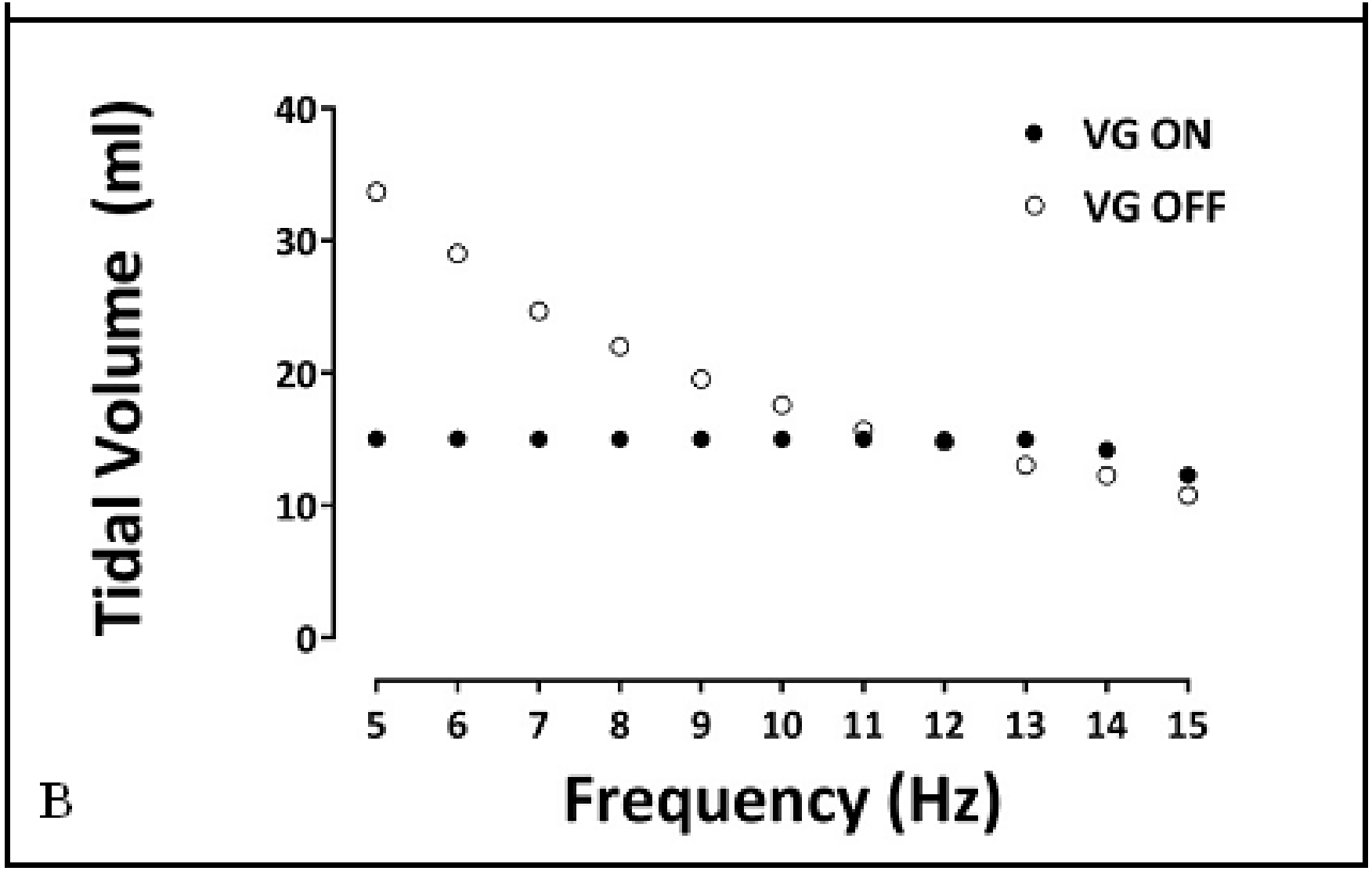
Adjustable continuous flow 100rnl/min

"Lung"

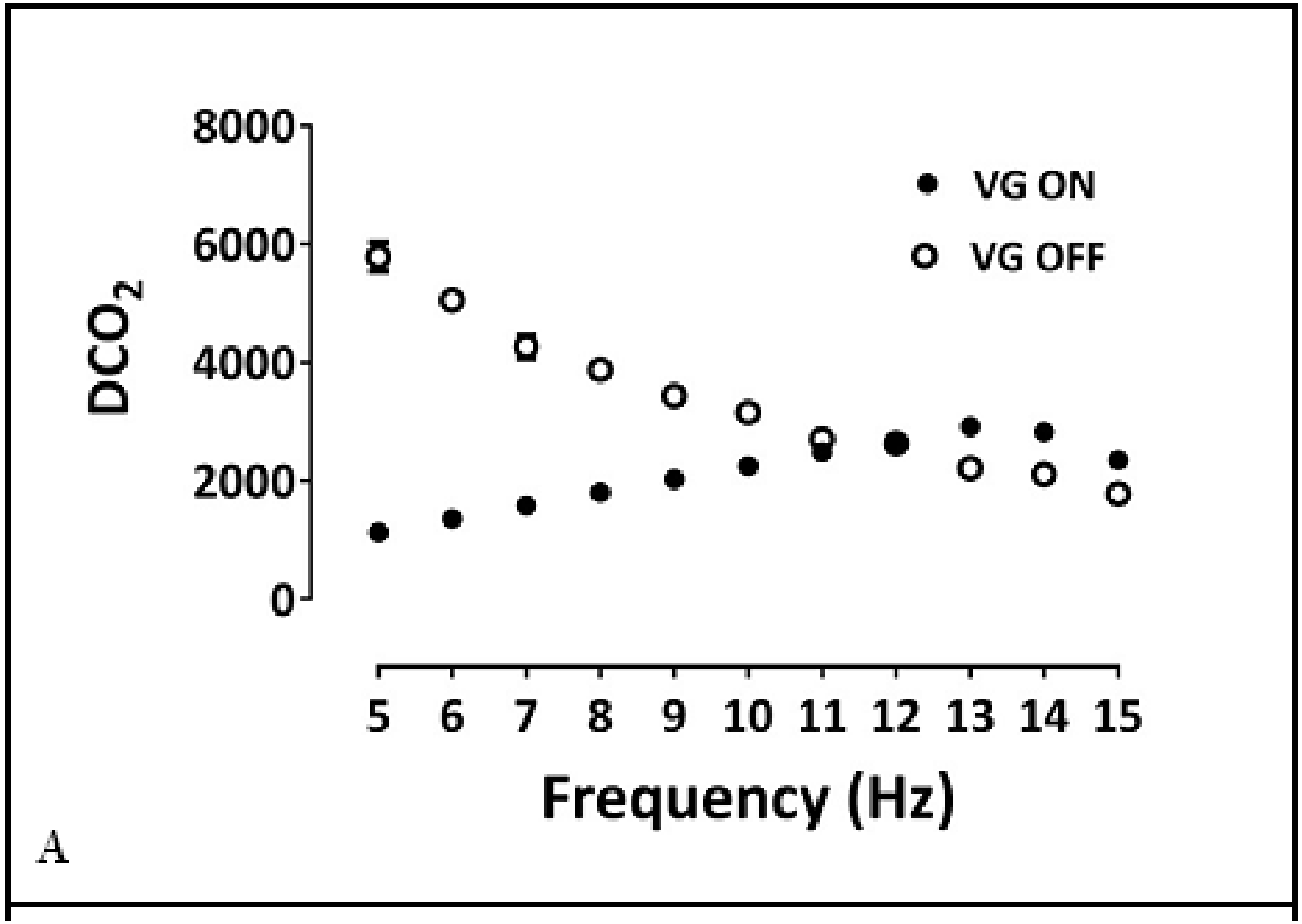
Volume: 500 ml

Airway Dead Space: 35 ml

Mukerji A Jaques Belik, Manuel Sanchez-Luna, J Perinatol 2014; 34 (6): 464-7.



Mukerji A Jaques Belik, Manuel Sanchez-Luna, J Perinatol 2014; 34 (6): 464-7.



Mukerji A Jaques Belik, Manuel Sanchez-Luna, J Perinatol 2014; 34 (6): 464-7.

VAFO+VG y presiones delta

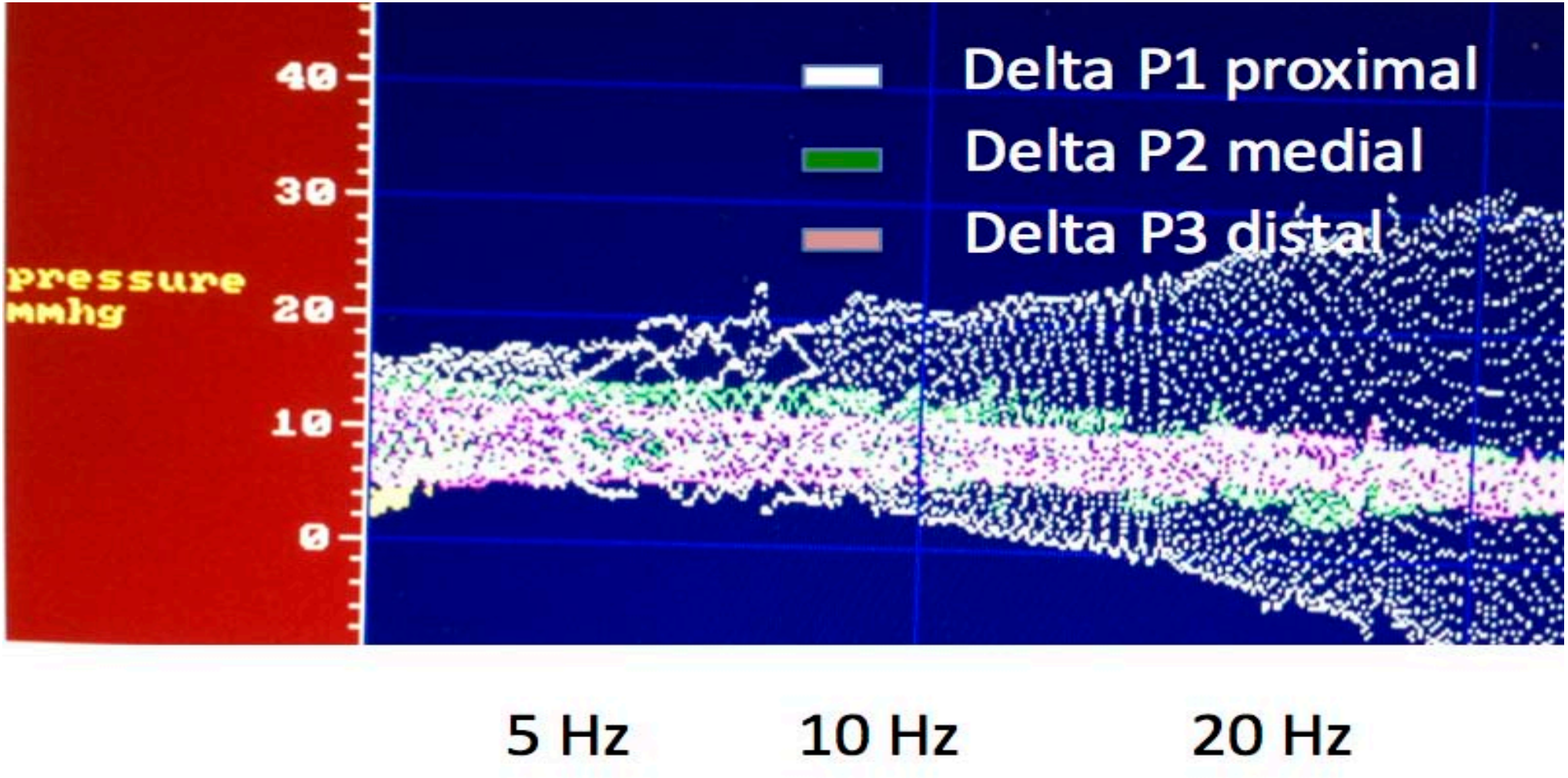
P1= Proximal

P2= Medial

P3= Distal

Mukerji A Jaques Belik, Manuel Sanchez-Luna, J Perinatol 2014; 34 (6): 464-7.

Delta Pressures



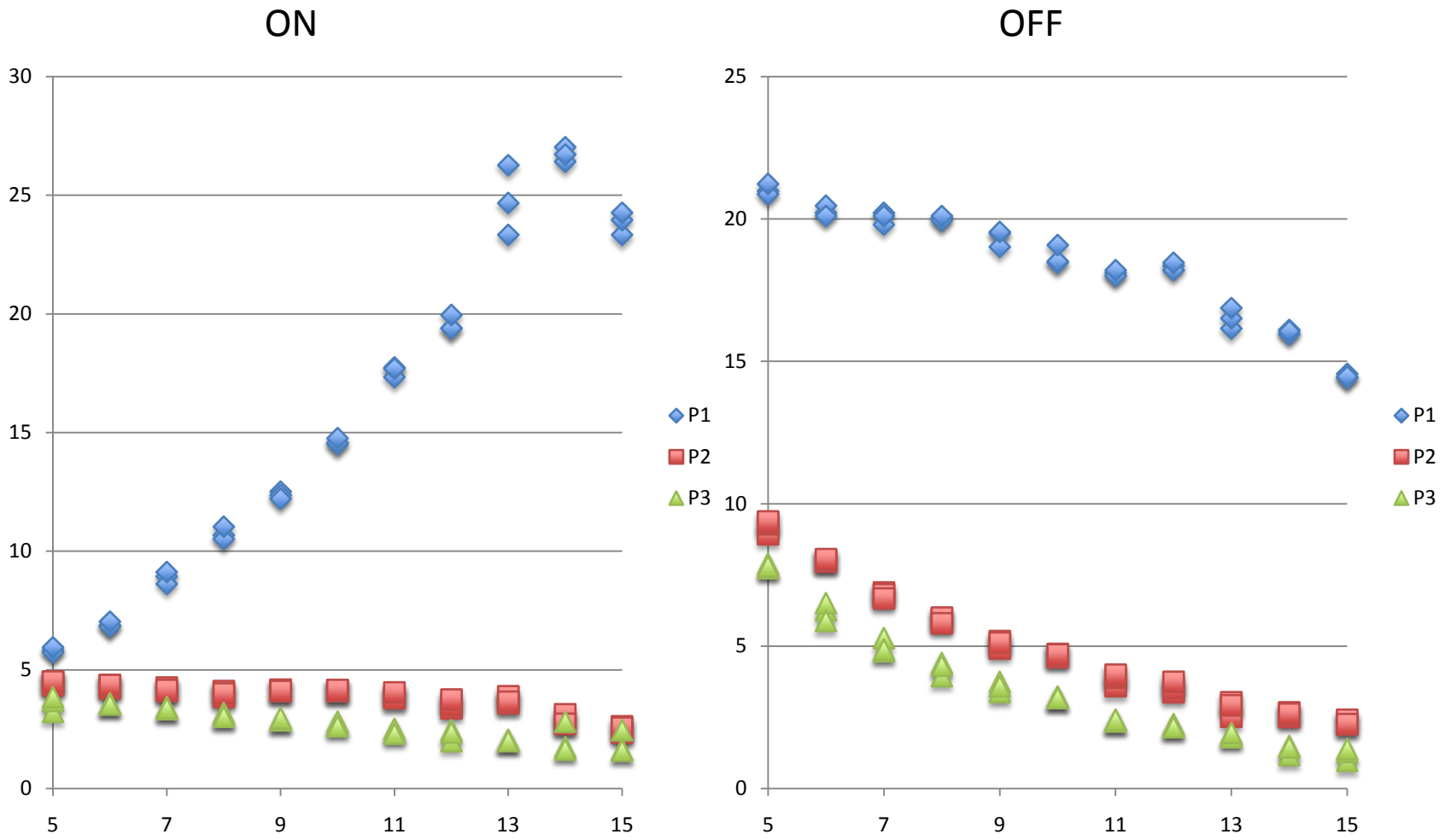
Mukerji A Jaques Belik, Manuel Sanchez-Luna, J Perinatol 2014; 34 (6): 464-7.

VG ON and OFF

P1: Proximal

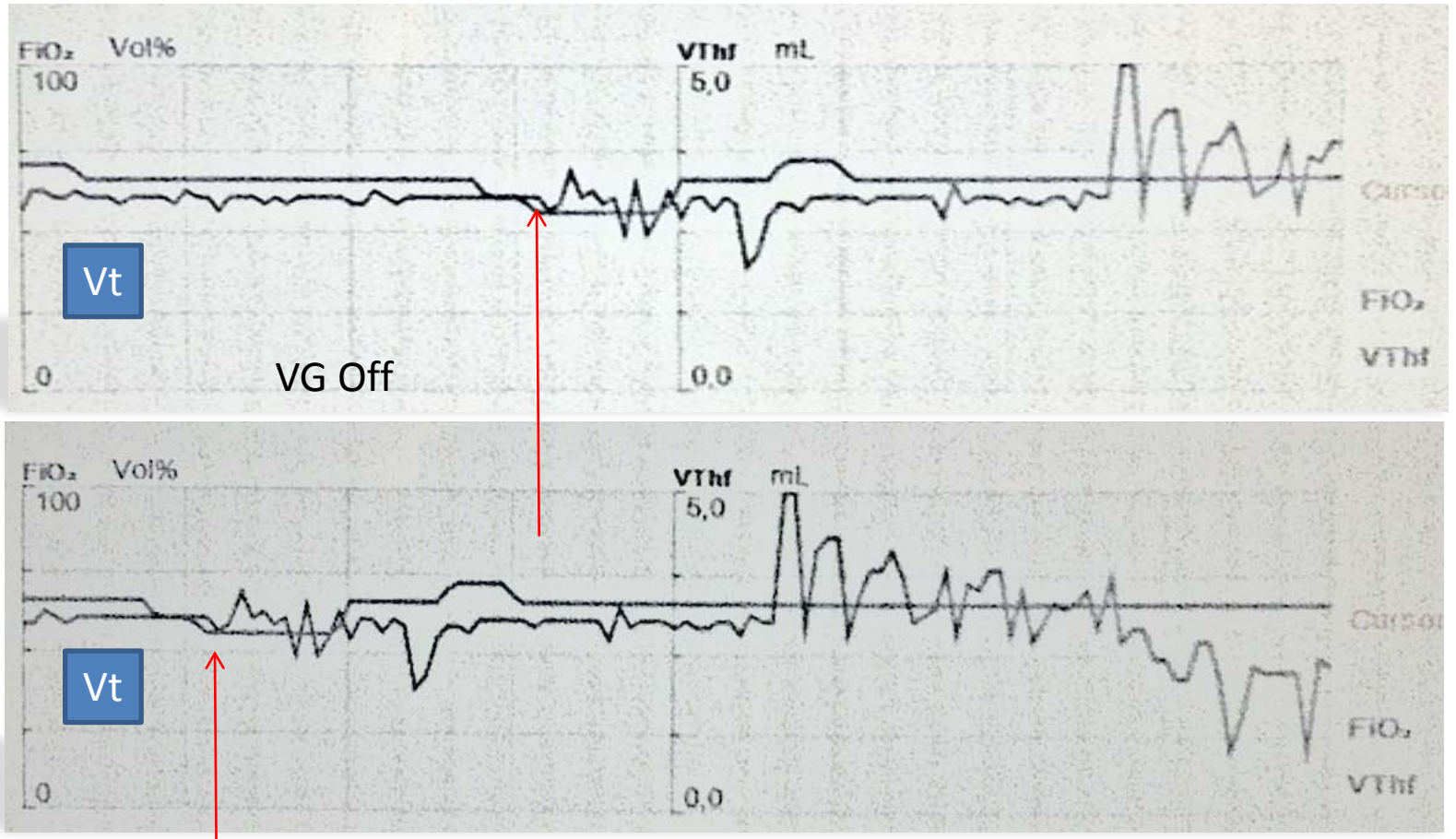
P2: Medial

P3: Distal



Mukerji A Jaques Belik, Manuel Sanchez-Luna, J Perinatol 2014; 34 (6): 464-7.

HFO + VG



Sanchez Luna 2010

Using very high frequencies with very low lung volumes during high-frequency oscillatory ventilation to protect the immature lung. A pilot study.

González-Pacheco N, Sánchez-Luna M, Ramos-Navarro C, Navarro-Patiño N, de la Blanca AR. J Perinatol 2016; (): .

Objective:
To use the lowest VtHf and maintain similar PCO2 by increasing the frequency

Table 1. Demographic and clinical characteristics of the patients

Gestational age (weeks)[a]	28.83 ± 4.69/27.40
< 32	19 (82.6%)
> 32	4 (17.4%)
Chronological age at the start of HFOV (days)[a]	5.52 ± 13.76/0
Birth weight (g)[a]	1113.78 ± 823.98/790.00
Weight at the start of HFOV (g)[a]	1211.35 ± 938.53/830.00
< 1000	14 (60.9%)
1000–2000	6 (26.1%)
> 2000	3 (13.0%)

N González-Pacheco et al, Journal of Perinatology 2016

Table 2. Initial and final settings of HFOV and patients' records

Ventilator settings	*Initial*	*Final*	*p*
mPaw (mbar)		13.56 ± 4.03	
I:E ratio		1:1	
Frequency (Hz)	10.39 ± 1.41	→ 16.70 ± 2.20	0.000
Tidal volume (ml kg^{-1})	2.20 ± 0.44	→ 1.59 ± 0.36	0.000
ΔP (mbar)	21.86 ± 8.69	→ 22.00 ± 8.64	0.915
DCO_2 ($ml^2\ s^{-1}$)	141.09 ± 271.98	→ 119.13 ± 223.86	0.129
FiO_2 (%)	47.87 ± 22.31	37.91 ± 16.06	0.020
Patients' records			
PAM (mm Hg)	36.04 ± 10.59	37.26 ± 7.94	0.492
HR (bpm)	143.43 ± 20.51	140.57 ± 15.48	0.424
SpO_2 (%)	90.70 ± 5.84	93.35 ± 2.90	0.030
PCO_2 (mm Hg)	51.22 ± 10.19	46.04 ± 6.52	0.013

N González-Pacheco et al, Journal of Perinatology 2016

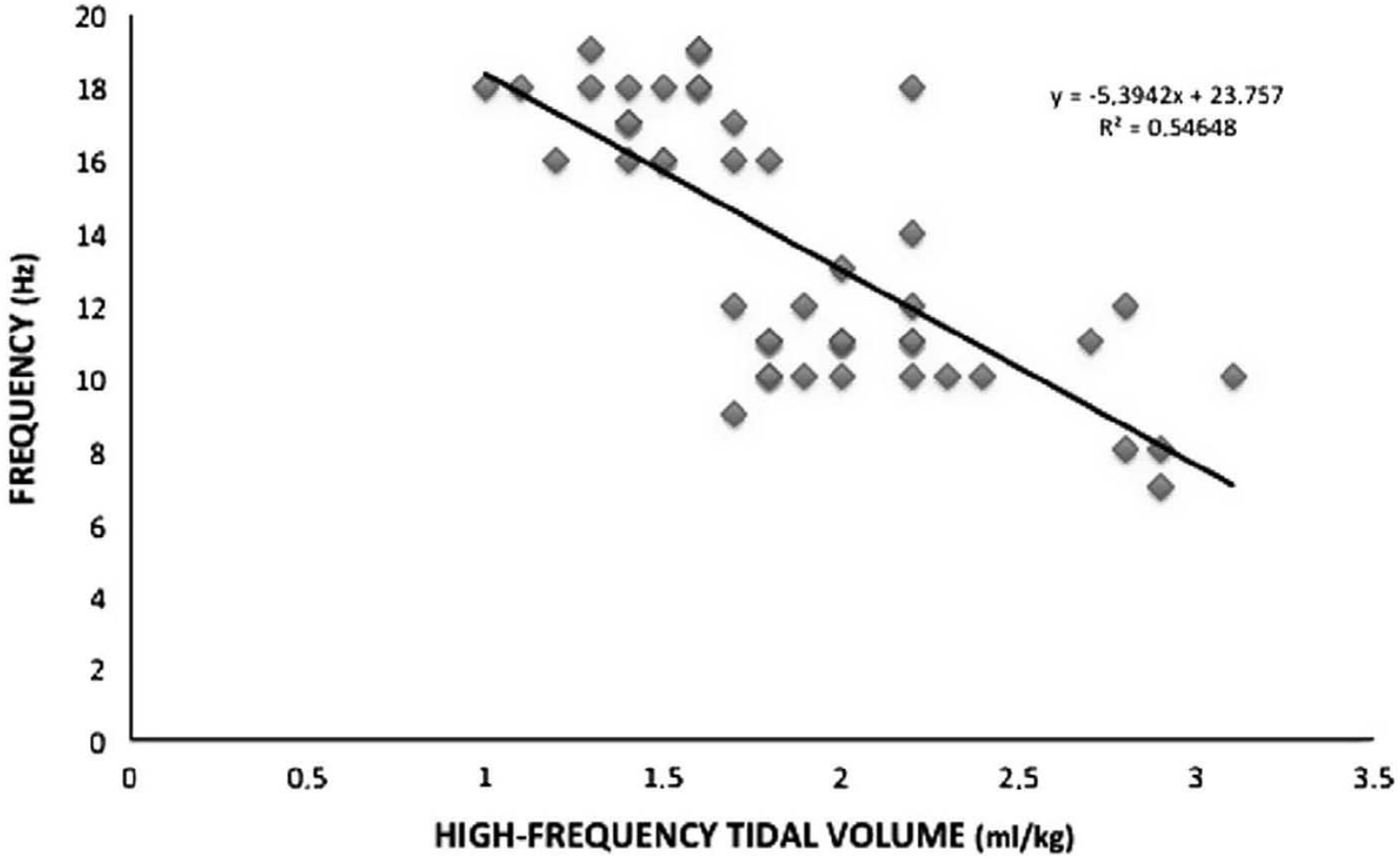
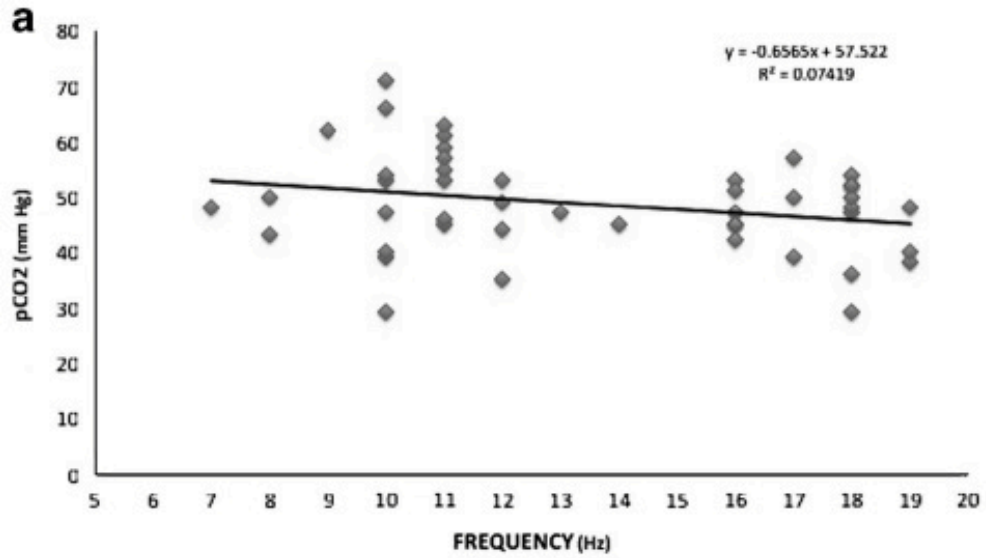


Figure 1. Initial and final frequencies and high-frequency tidal volumes.

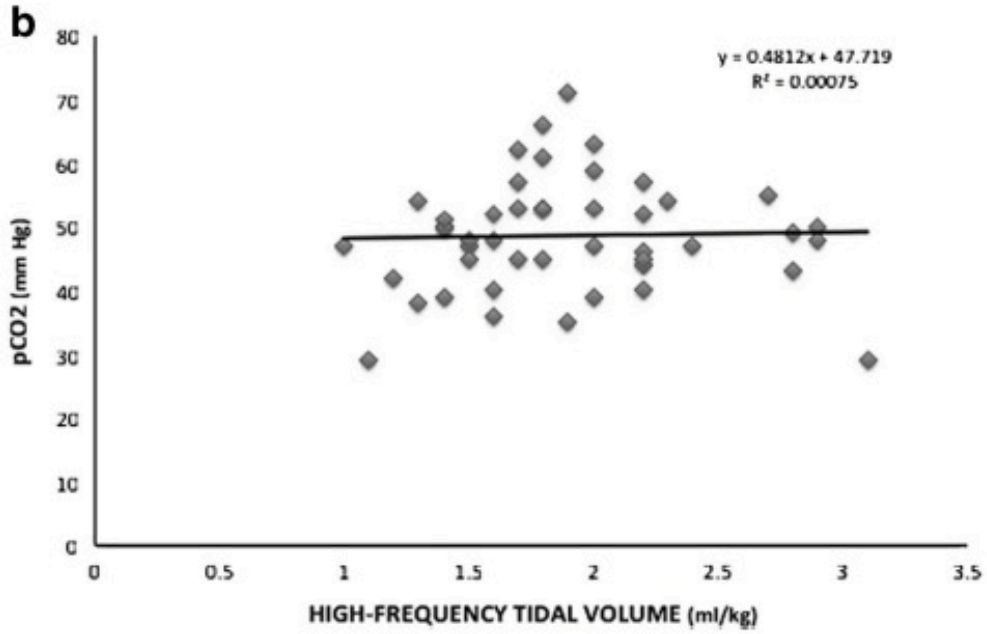
N González-Pacheco et al, Journal of Perinatology 2016

pCO_2



Frequency Hz

pCO_2



Vt ml

N González-Pacheco et al, Journal of Perinatology 2016

Journal of Perinatology
https://doi.org/10.1038/s41372-019-0338-5

ARTICLE

Use of very low tidal volumes during high-frequency ventilation reduces ventilator lung injury

Noelia González-Pacheco[1] · Manuel Sánchez-Luna[1] · Paz Chimenti-Camacho[1] · Martín Santos-González[2] · Paula Palau-Concejo[3] · Francisco Tendillo-Cortijo[2]

Received: 26 July 2018 / Revised: 13 December 2018 / Accepted: 28 January 2019

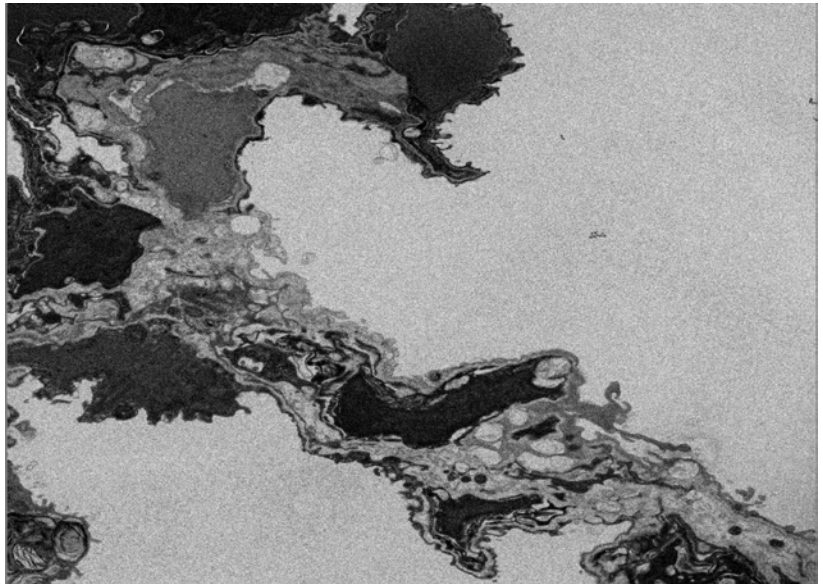
HFOV+VG very high frequencies

- 10 Hz vs 20 Hz
- Animal newborn model
- 12 hours of HFOV after BAL

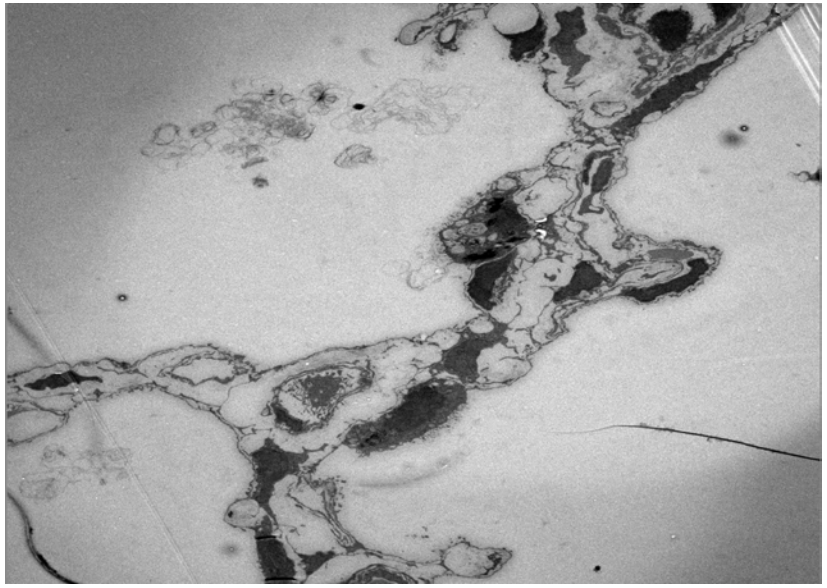
González Pacheco N, Sanchez Luna M, J of Perinatology 2019

Efecto sobre el pulmón

10 Hz, 12 horas HFOV+VG



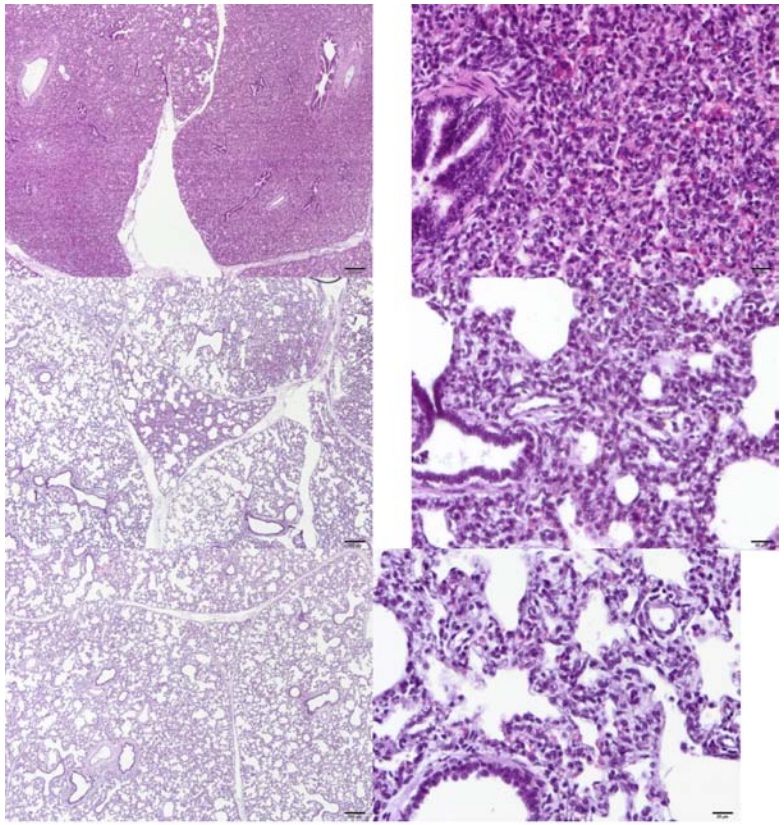
20 Hz, 12 horas HFOV+VG



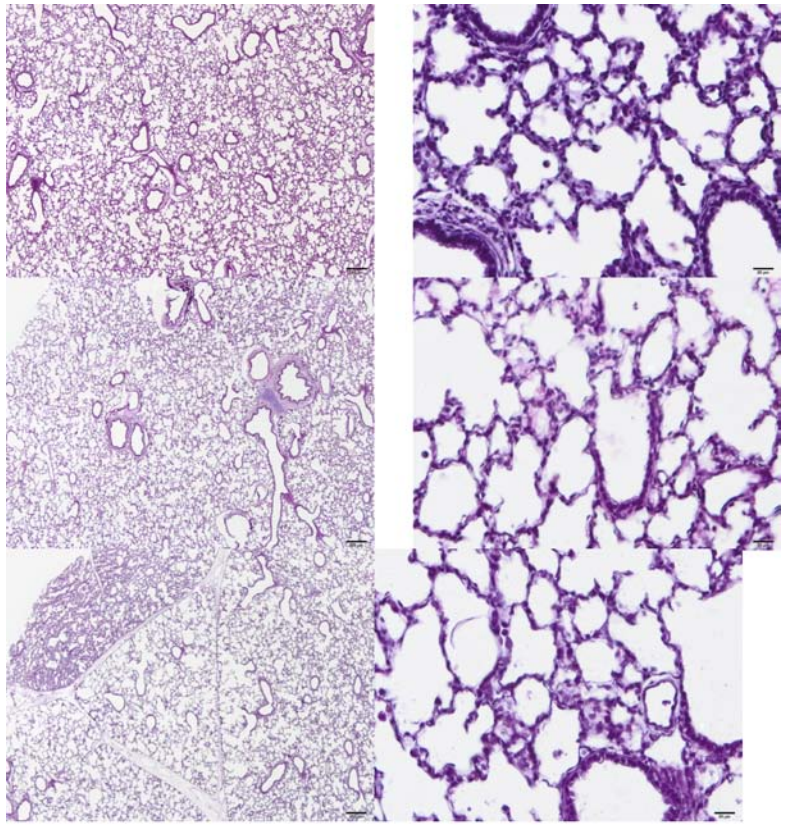
González Pacheco N, Sanchez Luna M, animal lab, 2018

Lung microscopy

10 Hz, 12 hours of HFOV+VG



20 Hz, 12 hours of HFOV+VG



González Pacheco N, Sanchez Luna M, J Perinatol 2019

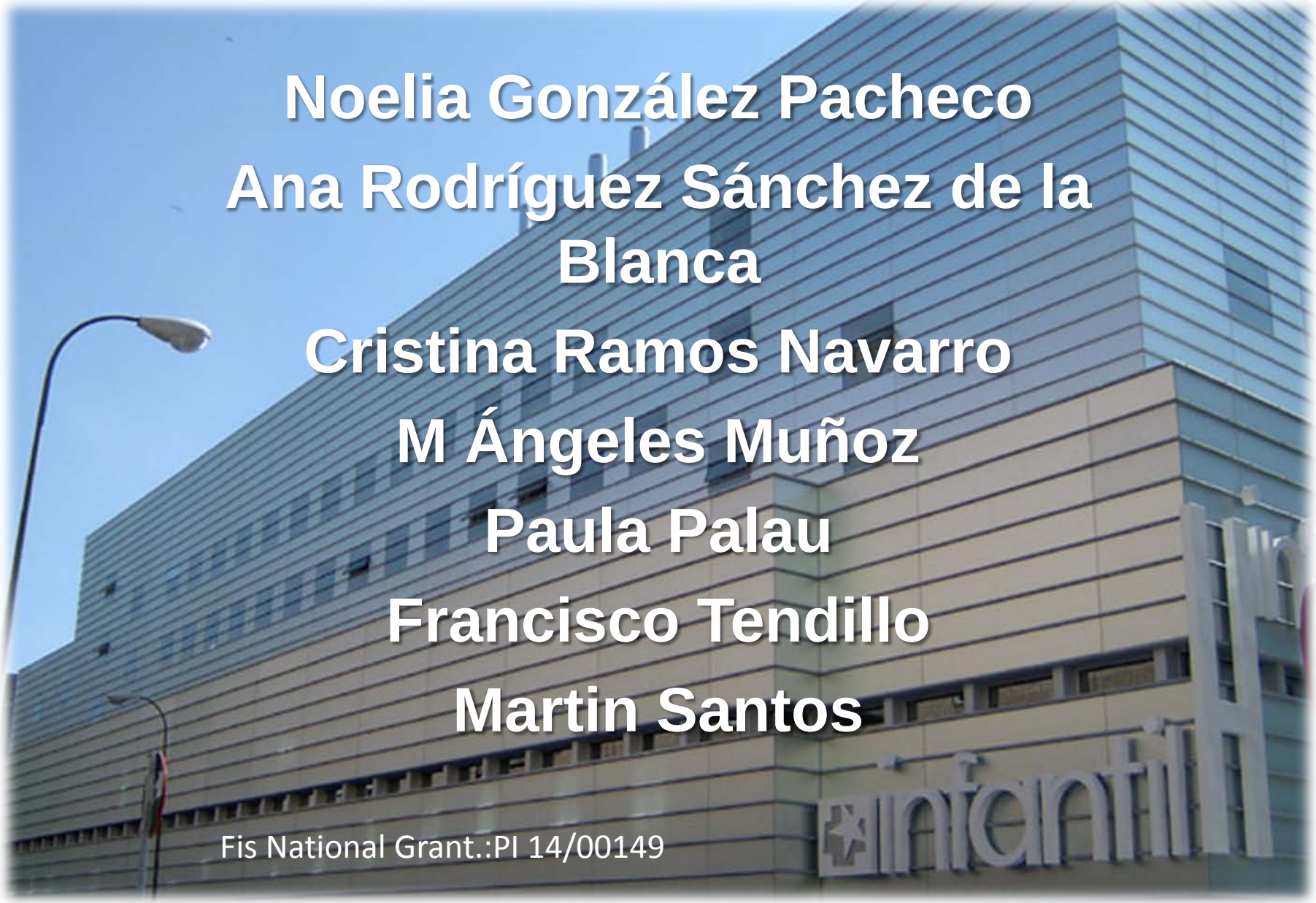
Lung microscopy

	10 Hz group				20 Hz group				CMV group			
Animal case	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Inflammation	3	2	4	3	1	2	0	0	1	1	1	3
Hemorrhage	1	1	3	0	0	0	0	0	0	0	0	0
Atelectasis	2	2	4	3	2	3	1	2	1	1	1	3
Edema	0	0	0	0	0	0	0	0	0	0	0	0
Emphysema	0	0	0	0	0	0	0	0	3	3	0	2
TOTAL SCORE	**28**				**11**				**20**			

González Pacheco N, Sanchez Luna M, J Perinatol 2019

Preguntas sobre HFOV + VG

1. Podemos modificar DCO_2 usando solo VtHf?
    1. Sí
2. Podemos aumentar DCO2 aumentando la frecuencia con VtHf fijo?
    1. Sí
3. Podemos usar frecuencias muy elevadas con VtHf muy bajos y DCO_2 similares?
    1. Sí
4. Podemos usar esta estrategia en RN?
    1. Sí
5. Podemos proteger el pulmón inmaduro con esta estrategia?
    1. Sí



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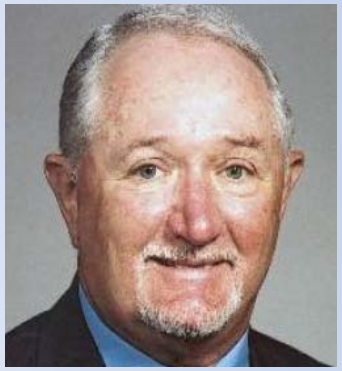
Prof Carlos Ramos


Dr. Michael Gottschalk


Prof Anup Katheria


Prof Avroy Fanaroff


Prof Horacio


Prof Sergio G. Golombek


Prof Jose Honold