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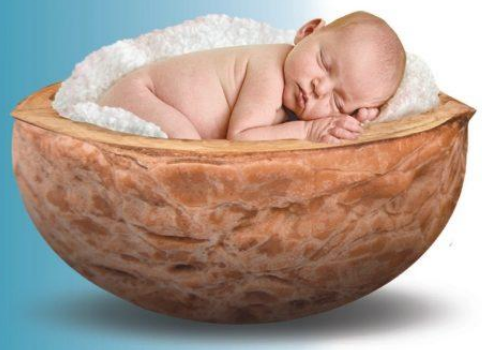

Respiratory function monitoring in the delivery room

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Sistema Socio Sanitario
Regione Lombardia
ASST Fatebenefratelli Sacco

Conflict of interest statement:

Dr Lista has received honoraria for lectures from Chiesi, Draeger and Vyaire Company. None of these Companies had any input into the content of this presentation

Clin Perinatol 42 (2015) 781–796

Mechanical Ventilation and Bronchopulmonary Dysplasia

Martin Keszler, MD[a,*], Guilherme Sant'Anna, MD, PhD, FRCPC[b]

KEYWORDS

- Mechanical ventilation • Bronchopulmonary dysplasia
- Ventilator-associated lung injury • Volume-targeted ventilation
- Lung-protective ventilation

KEY POINTS

- Mechanical ventilation (MV) is an important potentially modifiable risk factor for the development of bronchopulmonary dysplasia (BPD).
- Effective use of noninvasive respiratory support reduces the risk of lung injury.
- Lung volume recruitment and avoidance of excessive tidal volume (V_T) are key elements of lung-protective ventilation strategies.
- Avoidance of oxidative stress, less invasive methods of surfactant administration, and high-frequency ventilation (HFV) are also important factors in lung injury prevention.

INTRODUCTION

MV is undoubtedly one of the key advances in neonatal care. Even in this era of noninvasive respiratory support, MV remains a mainstay of therapy in the extremely preterm population. Data from the Neonatal Research Network show that 89% of extremely low birth weight (ELBW) infants were treated with MV during the first day of life.[1] Among survivors, almost 95% were invasively ventilated at some point during their hospital stay. In the Surfactant, Positive Pressure, and Oxygenation Randomized Trial

Consensus Guidelines

Neonatology

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European Consensus Guidelines on the Management of Respiratory Distress Syndrome – 2016 Update

David G. Sweet[a] Virgilio Carnielli[b] Gorm Greisen[c] Mikko Hallman[d]
Eren Ozek[e] Richard Plavka[f] Ola Didrik Saugstad[g] Umberto Simeoni[h]
Christian P. Speer[i] Máximo Vento[j] Gerard H.A. Visser[k] Henry L. Halliday[l]

Mechanical Ventilation Strategies

Recommendations

1 After stabilization, MV should be used in babies with RDS when other methods of respiratory support have failed (A1). Duration of MV should be minimized (B2).

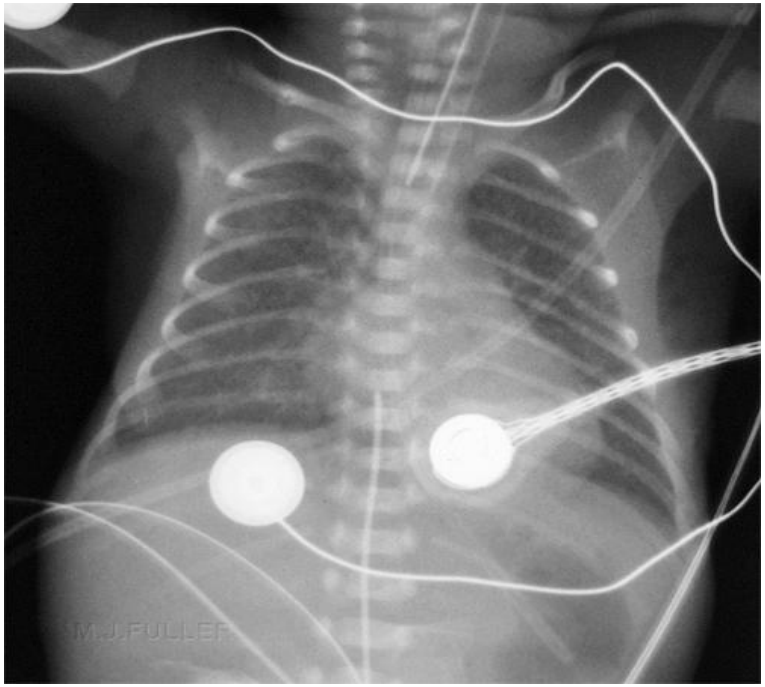
2 Targeted tidal volume ventilation should be employed as this shortens the duration of ventilation and reduces BPD and intraventricular haemorrhage (A1).

3 Avoid hypocarbia (A1) as well as severe hypercarbia (C2) as these are associated with an increased risk of brain injury. When weaning from MV, it is reasonable to tolerate a modest degree of hypercarbia, provided the pH remains above 7.22 (B2).

4 Caffeine should be used to facilitate weaning from MV (A1). Early caffeine should be considered for all babies at high risk of needing MV, such as those <1,250 g birth weight, who are managed on non-invasive respiratory support (C1).

5 A short tapering course of low-dose dexamethasone should be considered to facilitate extubation in babies who remain on MV after 1–2 weeks (A2).

6 Inhaled steroids cannot be recommended for routine use to reduce BPD until further safety data become available.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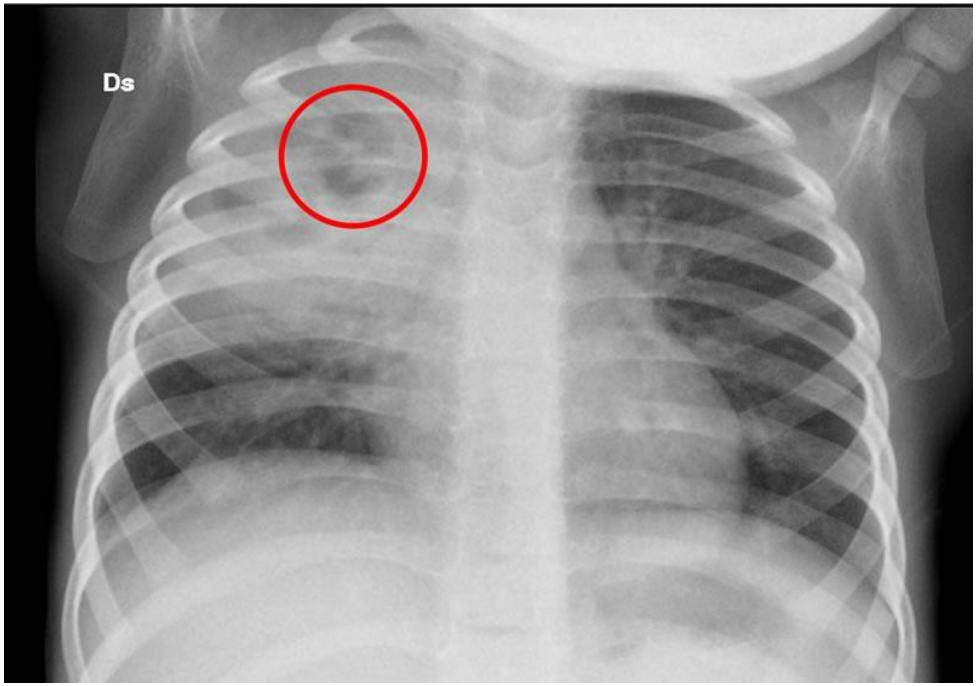
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Medical progress

Trends in conventional mechanical ventilation and pulmonary graphics in the newborn

Kris C. Sekar

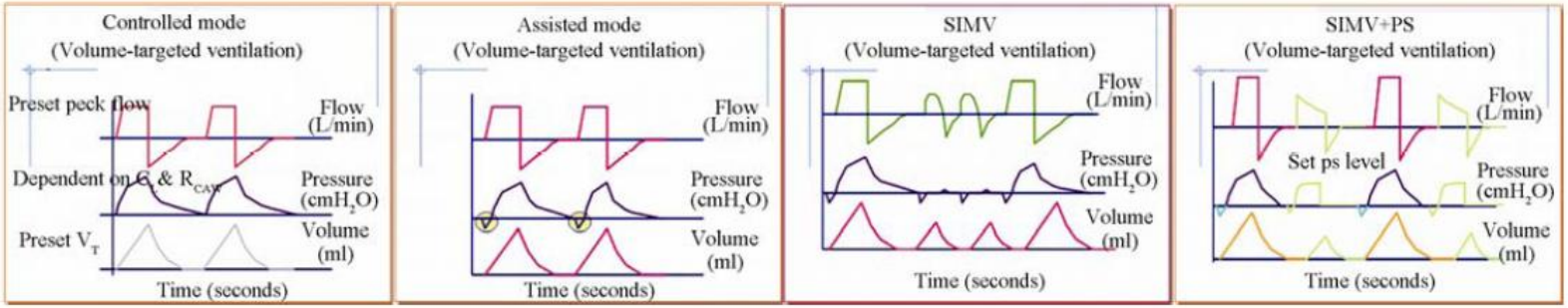

Figure 8. Scalar tracings showing control mode, SIMV mode, assist mode and SIMV with pressure support. Notice that the ventilator breaths look different from spontaneous breaths.

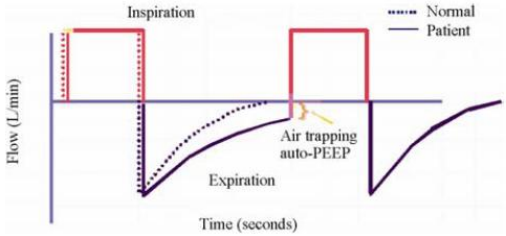

Figure 4. Typical flow wave form showing inspiratory and expiratory flow and auto-PEEP.

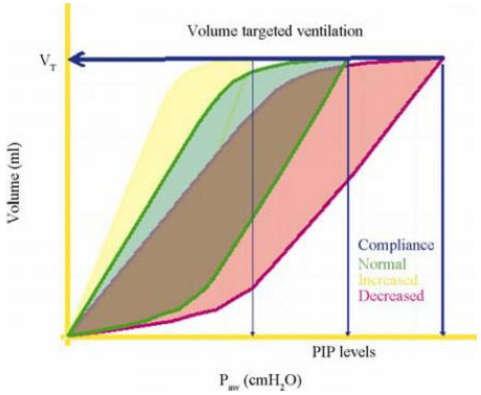

Figure 6. Pressure-volume loop showing change in compliance.

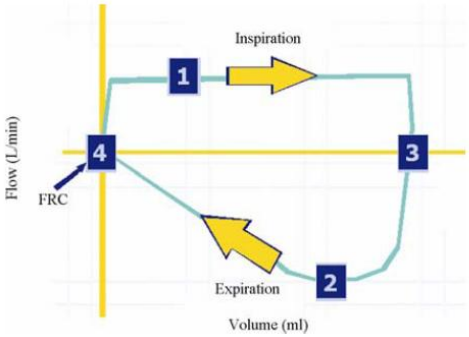

Figure 7. Flow volume loop showing inspiratory and expiratory flow.

Consensus Guidelines

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European Consensus Guidelines on the Management of Respiratory Distress Syndrome – 2016 Update

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Christian P. Speer[i] Máximo Vento[j] Gerard H.A. Visser[k] Henry L. Halliday[l]

Delivery Room Stabilization

Recommendations

1 If possible delay clamping the umbilical cord for at least 60 s to promote placentofetal transfusion (B1). Cord milking is a reasonable alternative if delayed cord clamping is not possible (B2).

2 Oxygen for resuscitation should be controlled using a blender. An initial concentration of 30% oxygen is appropriate for babies <28 weeks' gestation, and 21–30% for those of 28–31 weeks, and adjustments up or down should be guided by pulse oximetry from birth (B2).

3 In spontaneously breathing babies, stabilize with CPAP of at least 6 cm H_2O via mask or nasal prongs (A1). Gentle positive pressure lung inflations using about 20–25 cm H_2O peak inspiratory pressure should be used for persistently apnoeic or bradycardic infants (B1).

4 Intubation should be reserved for babies who have not responded to positive pressure ventilation via face mask (A1). Babies who require intubation for stabilization should be given surfactant (B1).

5 Plastic bags or occlusive wrapping under radiant warmers should be used during stabilization in the delivery suite for babies <28 weeks' gestation to reduce the risk of hypothermia (A1).

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Improving Assisted Ventilation Immediately after Birth

The initiation of breathing at birth is a dynamic process that involves clearing the airways and lungs of fluid and filling the lungs with air. When the newborn does not initiate breathing or does not breathe adequately, care providers assist ventilation to stabilize the newborn's cardiorespiratory status. Most of the time, the assisted ventilation is provided briefly and therefore most appropriately is provided non-invasively. Providing non-invasive ventilation is a skill that is not always easily mastered. Even for individuals with the highest skill level or for invasive ventilation, delivering the correct amount of ventilation

See related articles, p 372 and p 377

term infants was previously measured to be approximately 12 mL/kg on average.[6] Newborn infants who are not spontaneously breathing or who have immature lungs may require different levels of assisted ventilation to establish good lung volumes.

Inadequate breaths may deliver air only to the anatomic dead space of the airways rather than to the alveolar spaces.[7] The lack of expansion of the lungs may impair the normal increase in pulmonary blood flow, and when this is uncorrected, the newborn would remain hypoxemic and bradycardic. Monitoring, therefore, also has potential to im-

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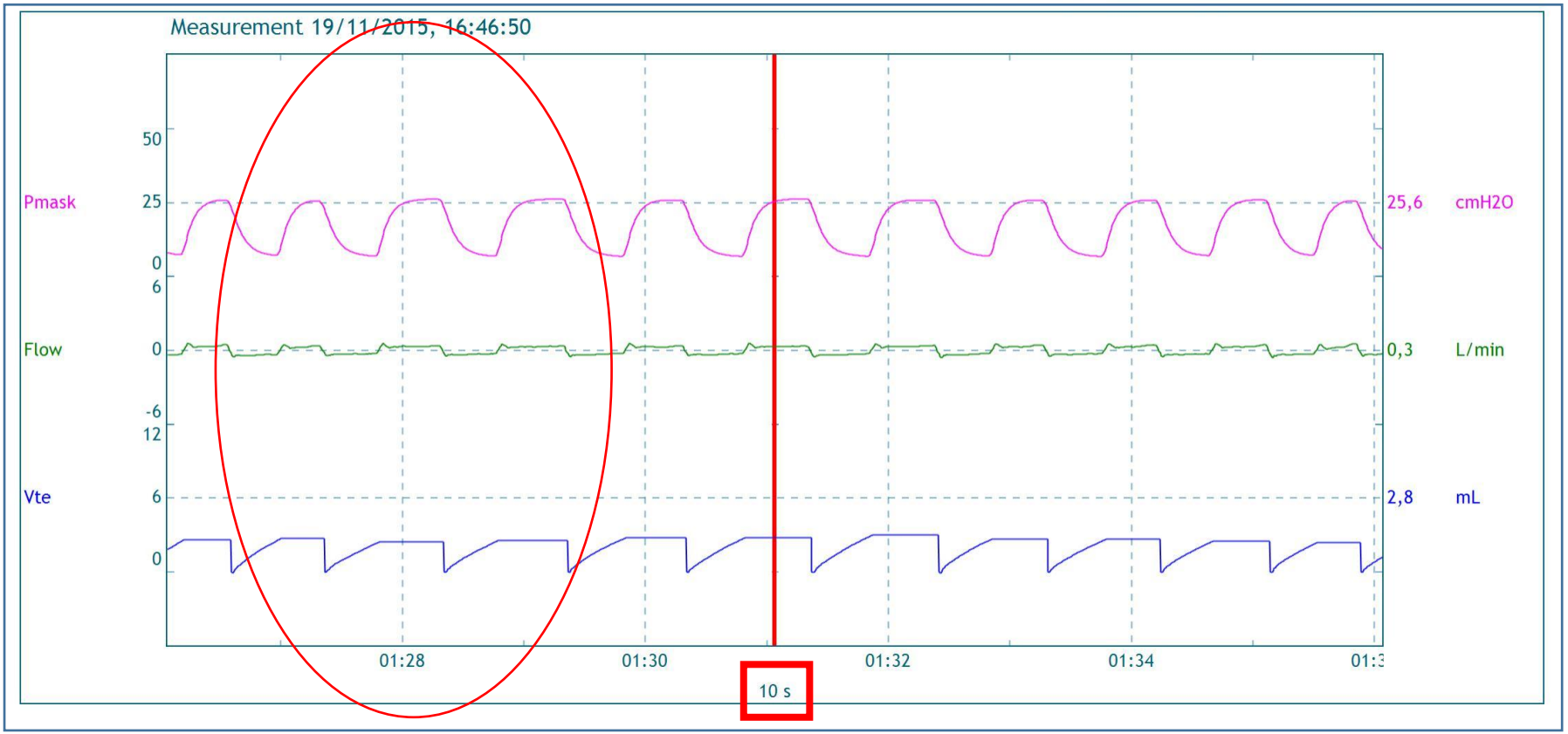
Perinatal Medicine & Neonatal Medicine, Pediatrics
University of California, San Diego
San Diego, California

Flow sensor in the RFM (in DR) and on the ventilator
(in DR and NICU)

RFM : measures and continuously displays *respiratory parameters* and can help to adjust the assisted ventilation to meet the newborn‘s requirements :

- Flow/Pressure
- SpO_2
- FiO_2
- Vt

Videorecording


Measurement 19/11/2015, 16:46:50
Pmask
50
25
0
25,6
cmH2O
Flow
6
0
-6
0,3
L/min
Vte
12
6
0
2,8
mL
01:28
01:30
01:32
01:34
10 s

Seminars in Fetal & Neonatal Medicine 18 (2013) 344–351

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Seminars in Fetal & Neonatal Medicine

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

Review

Face mask ventilation – the dos and don'ts

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Keywords:
Continuous positive airway pressure
Infant
Masks
Positive end-expiratory pressure
Positive pressure ventilation
Resuscitation

S U M M A R Y

Face mask ventilation provides respiratory support to newly born or sick infants. It is a challenging technique and difficult to ensure that an appropriate tidal volume is delivered because large and variable leaks occur between the mask and face; airway obstruction may also occur. Technique is more important than the mask shape although the size must appropriately fit the face. The essence of the technique is to roll the mask on to the face from the chin while avoiding the eyes, with a finger and thumb apply a strong even downward pressure to the top of the mask, away from the stem and sloped sides or skirt of the mask, place the other fingers under the jaw and apply a similar upward pressure. Preterm infants require continuous end-expiratory pressure to facilitate lung aeration and maintain lung volume. This is best done with a T-piece device, not a self-inflating or flow-inflating bag.

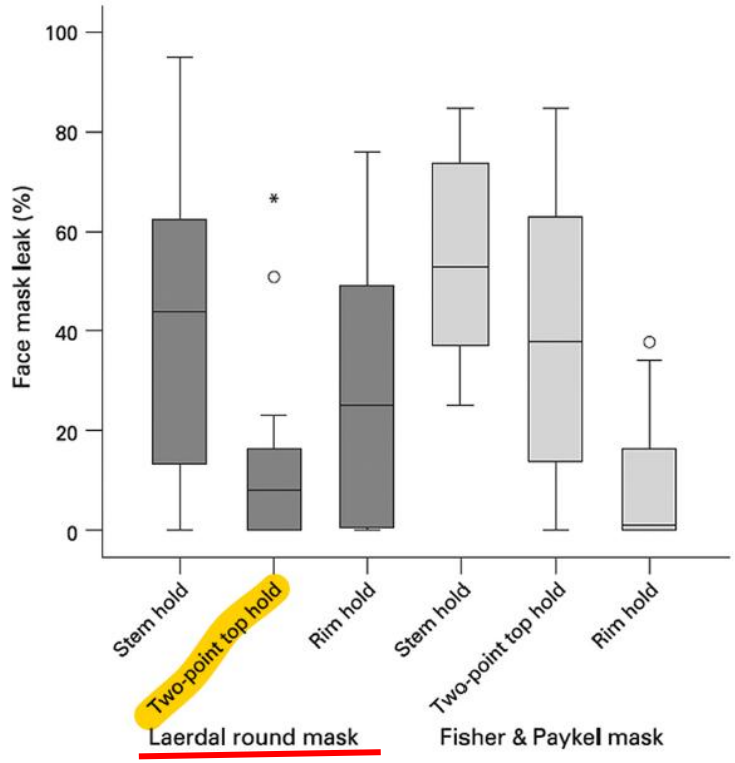


Fig. 2. Percentage leak at the face mask for two face masks: Laerdal size 0/1 (dark shading) and Fisher and Paykel 60 mm (light shading) and three hold type. Box plots show median values (solid lines), interquartile range (margins of box), range of data, outliers (circles) and extreme values (asterisk). From Wood et al [12].

15. Face mask ventilation training

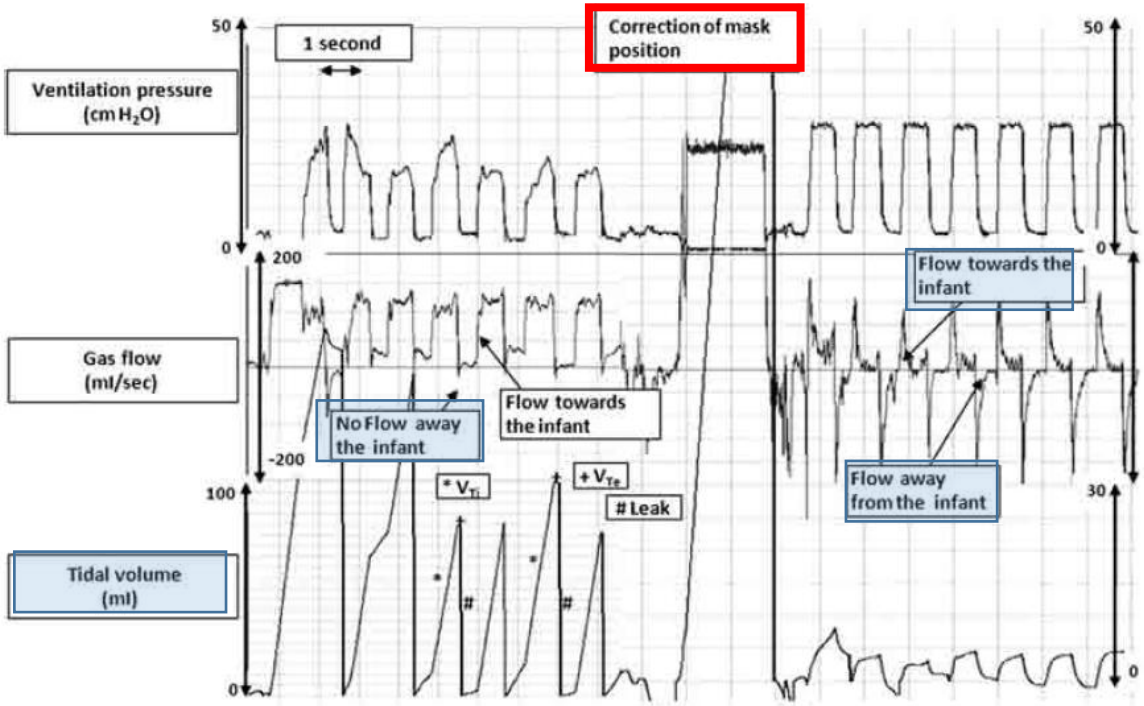
Training in this fundamental skill has traditionally been undertaken using manikins. Accurate feedback mechanisms for candidate performance have not been available. Manikin and infant studies have shown that resuscitator performance and clinical outcomes are improved by the use of a respiratory function monitor [46,47]. Newer training courses are now adopting systems to provide real-time objective performance feedback.

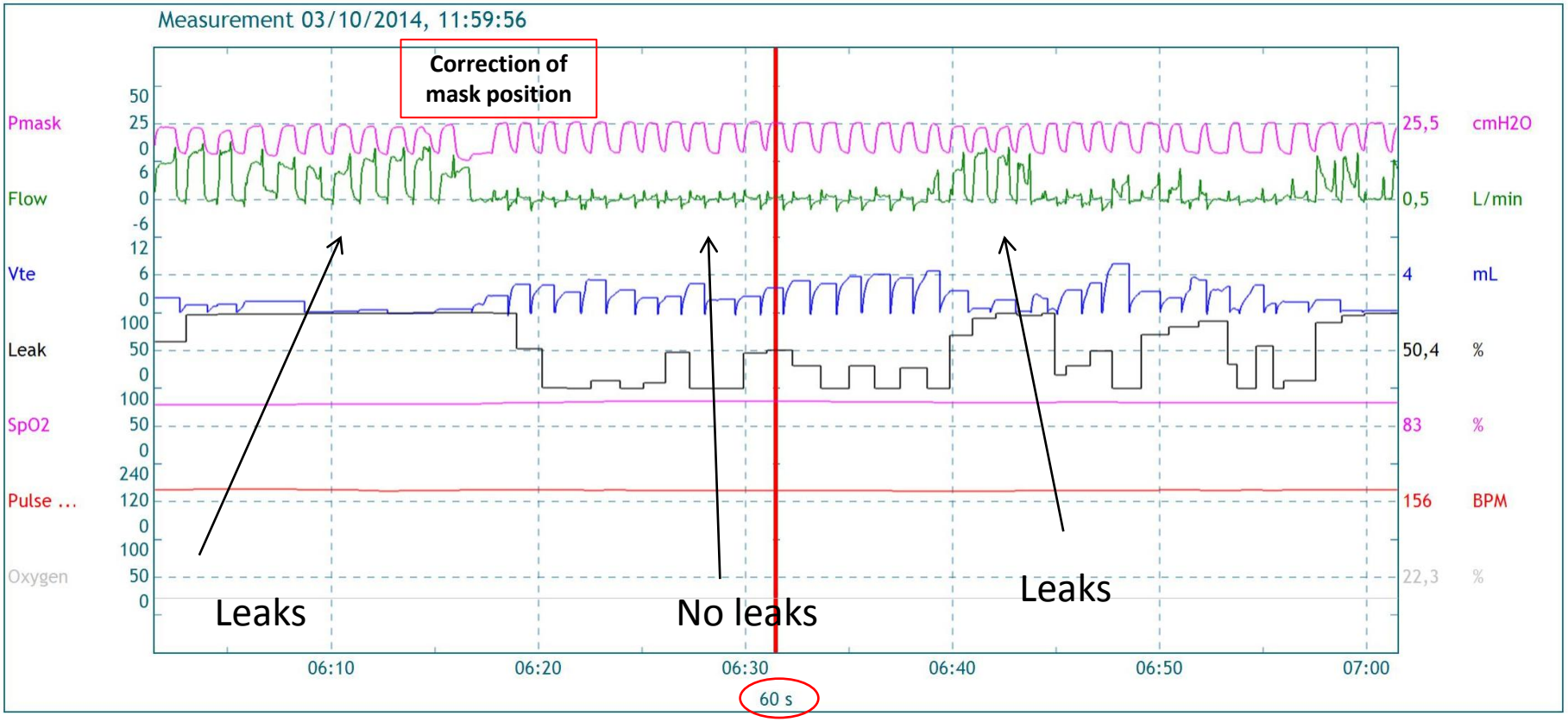
Respiratory monitoring of neonatal resuscitation

Georg M Schmölzer,[1–4] Omar C O F Kamlin,[1] Jennifer A Dawson,[1,3,5] Arjan B te Pas,[6] Colin J Morley,[1,3,5] Peter G Davis[1,3,5]

Arch Dis Child Fetal Neonatal Ed 2010;**95**:F295–F303. doi:10.1136/adc.2009.165878

Figure 3 Positive pressure ventilation with a face mask on a manikin: no leak. The inflation and expiratory flow curves return to the baseline, indicating sufficient t_I and t_E. The similar areas underneath the inflation and expiration flow curves mean an equal amount of gas entered and left the airways. The tidal volume curve shows the inspiratory and expiratory tidal volumes (V_{Ti} and the V_{Te}). It shows an equal volume of gas entering and leaving the lung and no leak. V_{Ti} has almost formed a plateau indicating that very little gas continues to enter the lung as inflation is continued.




Measurement 03/10/2014, 11:59:56
Correction of mask position
Pmask
Flow
Vte
Leak
SpO2
Pulse ...
Oxygen
25,5
cmH2O
0,5
L/min
4
mL
50,4
%
83
%
156
BPM
22,3
%
Leaks
No leaks
Leaks
06:10
06:20
06:30
06:40
06:50
07:00
60 s

A respiratory function monitor improves mask ventilation

F E Wood,[1] C J Morley,[1,2,3] J A Dawson,[1] P G Davis[1,2]

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ABSTRACT

This study investigated whether the use of a respiratory monitor during simulated neonatal resuscitation reduced leak at the face mask. It showed the leak was more than halved, being reduced from 27% to 11% when 25 participants used the monitor to identify and correct the mask leak.

In studies using a modified manikin, we investigated face masks during simulated neonatal resuscitation.[1–4] We found mask leaks are large and variable, irrespective of mask design or the operator's experience, with the mean (SD) leak being 55 (31)%.[3] Operators were unaware of the magnitude of the leak.[3] We showed that teaching techniques of holding face masks reduced the leak to 33 (26)%.[4]

Inadequate tidal volumes as a result of mask leak may result in failure to resuscitate an infant and

The Spectra physiological recording programme (Grove Medical, London, UK) acquired data from the Florian monitor onto a computer.

Study protocol

Participants were instructed to give positive pressure ventilation (PPV) at about 60/min with a peak inspiratory pressure (PIP) of 30 cm H_2O and a positive end-expiratory pressure (PEEP) of 5 cm H_2O for 1 min, ensuring good chest rise.

Before any recordings were made, the participants familiarised themselves with the Florian and holding the face mask. A recording was made with the monitor covered, so that the participants could not see the display. They were then instructed to use the display to achieve minimal mask leak. The second recording started when participants indicated they were satisfied with the Florian display. A third recording was made with the Florian

Airway obstruction and gas leak during mask ventilation of preterm infants in the delivery room

Georg M Schmölzer,[1–4] Jennifer A Dawson,[1,3,5] C Omar F Kamlin,[1]
Colm PF O'Donnell,[6] Colin J Morley,[1,3] Peter G Davis[1,3,5]

Arch Dis Child Fetal Neonatal Ed 2011;**96**:F254–F257.

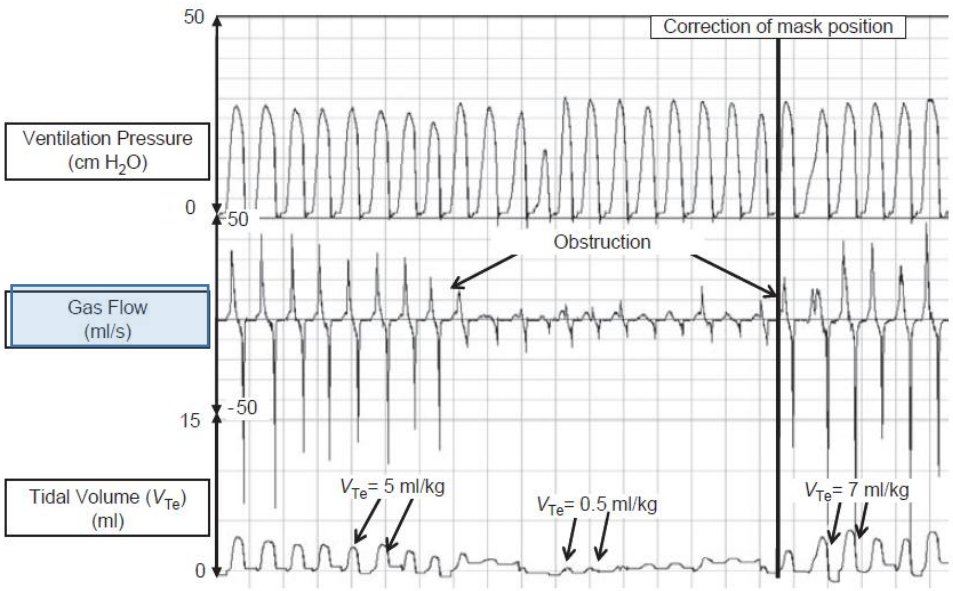
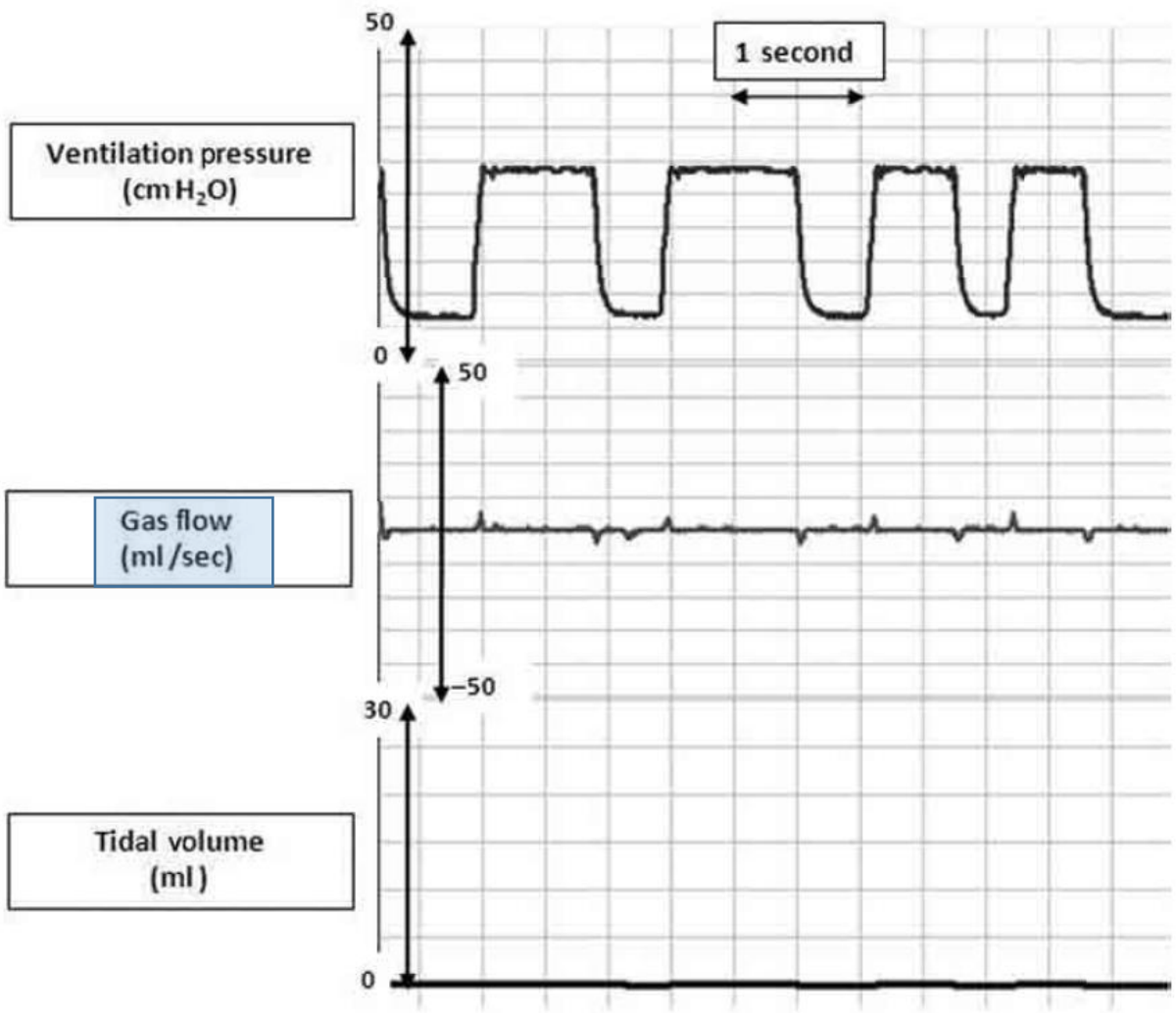


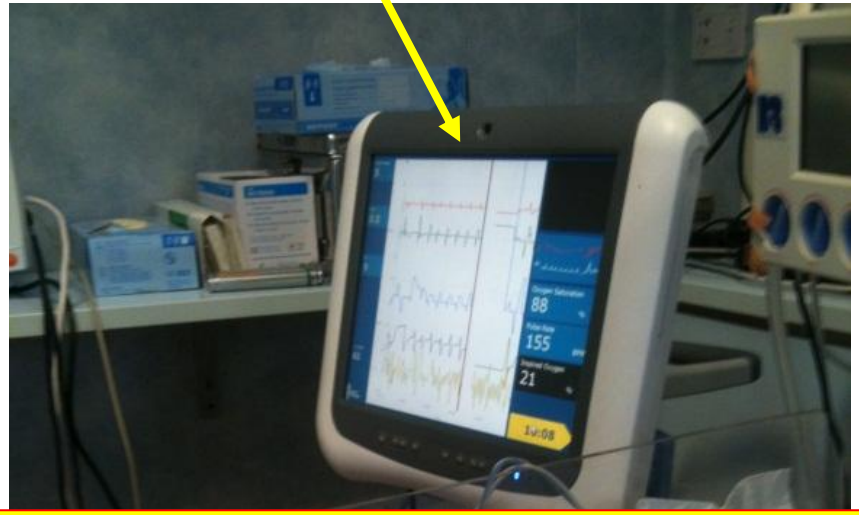
Figure 1 Airway obstruction during mask positive pressure ventilation (PPV) in a very preterm infant with a self-inflating bag. Initially, PPV delivered an expired tidal volume (V_{Te}) of 5 ml/kg. Both inflation and expiratory flow waves rapidly reduced in size. This is reflected in the V_T curve, which displays a 90% reduction in V_{Te}. By correcting the face-mask position, the tidal volume is restored. Throughout PPV, the peak inflation pressure is achieved.

Figure 8 Complete airway occlusion during facemask positive pressure ventilation (PPV) in an extremely low birthweight (ELBW) infant. The peak airway pressure and positive end expiratory pressure are maintained during PPV, but the inflation and expiratory flow curves display almost no flow movements. This is reflected in the tidal volume (V_T) curve, which displays no tidal volume.



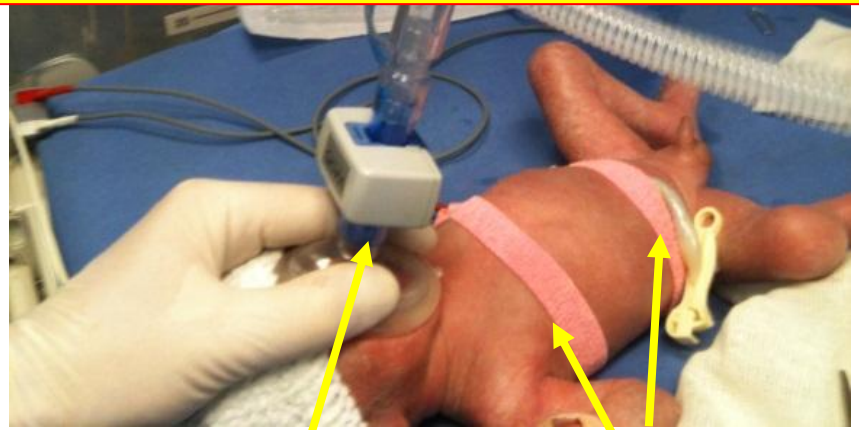
Arch Dis Child Fetal Neonatal Ed 2010;**95**:F295–F303. doi:10.1136/adc.2009.165878

Respiratory Function Monitor (RFM)



T-piece resuscitator

Monitoring lung aeration



Volumetric CO_2 monitor

Respiratory Inductance Plethysmography (RIP)

OPEN ACCESS Freely available online July 2014 | Volume 9 | Issue 7 | e102729 PLOS | ONE

Monitoring Lung Aeration during Respiratory Support in Preterm Infants at Birth

Liane J. Kang[1,2], Po-Yin Cheung[1,2], Gerhard Pichler[1,2,3], Megan O'Reilly[1,2], Khalid Aziz[1,2], Georg M. Schmölzer[1,2,3]*

1 Division of Neonatology, Department of Pediatrics, University of Alberta, Edmonton, Canada, **2** Neonatal Research Unit, Royal Alexandra Hospital, Alberta Health Services, Edmonton, Canada, **3** Division of Neonatology, Department of Pediatrics, Medical University, Graz, Austria

Background: If infants fail to initiate spontaneous breathing, resuscitation guidelines recommend respiratory support with positive pressure ventilation (PPV). The purpose of PPV is to establish functional residual capacity and deliver an adequate tidal volume (V_T) to achieve gas exchange.

Objective: The aim of our pilot study was to measure changes in exhaled carbon dioxide (ECO_2), V_T, and rate of carbon dioxide elimination (VCO_2) to assess lung aeration in preterm infants requiring respiratory support immediately after birth.

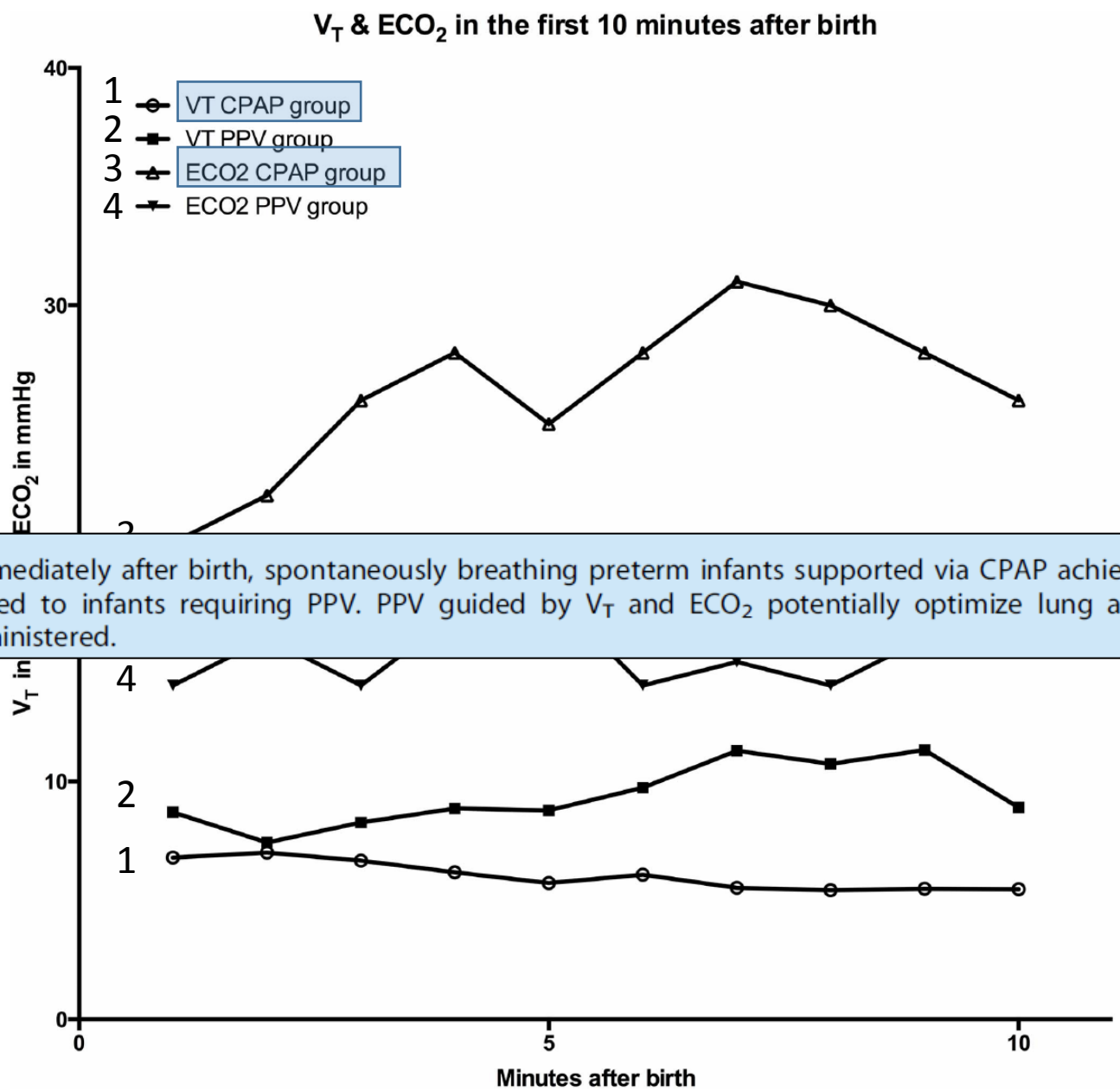
Method: A prospective observational study was performed between March and July 2013. Infants born at <37 weeks gestational age who received continuous positive airway pressure (CPAP) or PPV immediately after birth had V_T delivery and ECO_2 continuously recorded using a sensor attached to the facemask.

Table 1. Demographics of study infants.

	CPAP group (n = 31)	PPV group (n = 20)
Birth weight (g)	1763 ± 487	1357 ± 709‡
Gestational age (weeks)	31 ± 2	29 ± 3‡
Male*	11 (35%)	7 (35%)
Antenatal steroids*	27 (87%)	12 (60%)‡
Cesarean section*	22 (71%)	13 (65%)
Apgar 1 minute#	6 (4–8)	4 (2–6)‡
Apgar 5 minutes#	8 (7–8)	7 (5–8)‡
Delayed cord clamping	18 (58%)	11 (55%)

Data are presented as mean ± SD unless indicated #median (IQR), *n (%), ‡$p < 0.05$.

doi:10.1371/journal.pone.0102729.t001

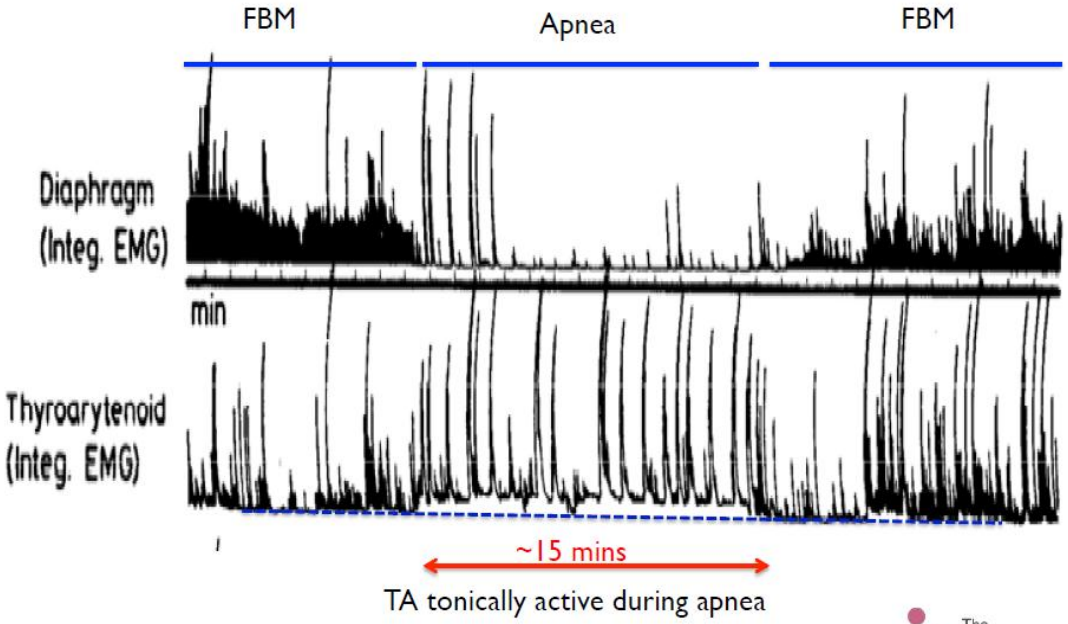


Conclusions: Immediately after birth, spontaneously breathing preterm infants supported via CPAP achieved better lung aeration compared to infants requiring PPV. PPV guided by V_T and ECO_2 potentially optimize lung aeration without excessive V_T administered.

Figure 1. Tidal volume (V_T) and exhaled CO_2 (ECO_2) during positive pressure ventilation (PPV) and in infants who are supported with continuous positive airway pressure (CPAP).

doi:10.1371/journal.pone.0102729.g001

Fetal glottis is tonically adducted during apnea



TA tonically active during apnea

Harding, Bocking & Sigger, J. Appl. Physiol. 60: 160-165, 1986

The Ritchie Centre

Hooper S, gentle concession, partly modified

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ORIGINAL ARTICLES

Evaluating Manual Inflations and Breathing during Mask Ventilation in Preterm Infants at Birth

Kim Schilleman, MD, PhD[1,*], Corinne J. M. van der Pot[1,*], Stuart B. Hooper, PhD[2], Enrico Lopriore, MD, PhD[1], Frans J. Walther, MD, PhD[1], and Arjan B. te Pas, MD, PhD[1]

Objective To investigate inflations (initial sustained inflations and consecutive inflations) and breathing during mask ventilation in preterm infants at birth.

Study design Resuscitation of infants <32 weeks' gestation receiving mask ventilation at birth were recorded. Recorded waveforms were divided into inflations (sustained and consecutive inflations), breaths in between inflations, breaths coinciding with an inflation, and breaths on continuous positive airway pressure (during evaluation moments in between and after ventilation) and expiratory tidal volume (V_{Te}) was compared. Inflations were analyzed for leak, low V_{Te} (<2.5 mL/kg), high V_{Te} (>15 mL/kg in sustained inflations, >10 mL/kg in consecutive inflations), and airway obstruction.

Results In 27 infants, we analyzed 1643 inflations, 110 breaths in between inflations, 133 breaths coinciding with an inflation, and 1676 breaths on continuous positive airway pressure. A large mask leak frequently resulted in low V_{Te}. Breathing during positive pressure ventilation occurred in 24 of 27 infants (89%). Median (IQR) V_{Te} of inflations, breaths in between inflations, and breaths coinciding with an inflation were 0.8 mL/kg (0.0-5.6 mL/kg), 2.8 mL/kg (0.7-4.6 mL/kg), and 3.9 mL/kg (0.0-7.7 mL/kg) during sustained inflations and 3.7 mL/kg (1.4-6.7 mL/kg), 3.3 mL/kg (2.1-6.6 mL/kg), and 4.6 mL/kg (2.1-7.8 mL/kg) during consecutive inflations, respectively. The V_{Te} of breaths were significantly lower than the V_{Te} of inflations or breaths coinciding with an inflation.

Conclusions We often observed large leak and low V_{Te}, especially during sustained inflations. Most preterm infants breathe when receiving mask ventilation and this probably contributed to the stabilization of the infants after birth. *(J Pediatr 2013;162:457-63)*.

Effectivity of ventilation by measuring expired CO_2 and RIP during stabilisation of preterm infants at birth

Jeroen J van Vonderen,[1] Gianluca Lista,[2] Francesco Cavigioli,[2] Stuart B Hooper,[3] Arjan B te Pas[1]

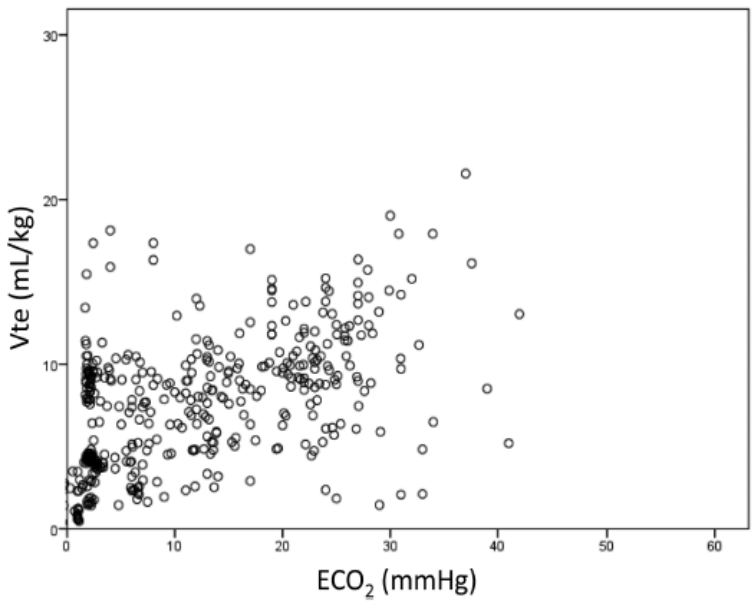


Figure 2 Scatterplot of expiratory tidal volume (Vte) (mL/kg) and expired CO_2 (ECO_2) (mm Hg) during positive pressure ventilation (PPV) not coinciding with breathing (R^2=0.283).

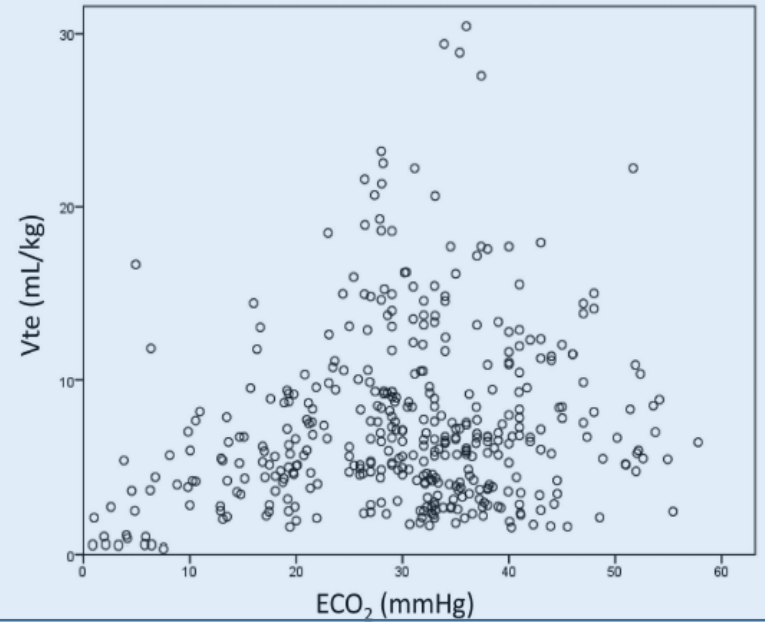


Figure 3 Scatterplot of expiratory tidal volume (Vte) (mL/kg) and expired CO_2 (ECO_2) (mm Hg) breathing on continuous positive airway pressure (R^2=0.052).

At the end of 1° SI	Breathing infants during SI (11 out of 15)	Apneic infants during SI (4 out of 15)
SBs (average) n°	4(3)	0
Vte (range) ml/Kg	5.9 (2.4-8.2)	5.2 (0.2-6.0) p<0.005
ECO2 (range) mmHg	16.0 (10-30)	5.0 (2.0-15.0) p<0.01

Spontaneuos breathing appears to play an important part in the success of ventilation given at birth

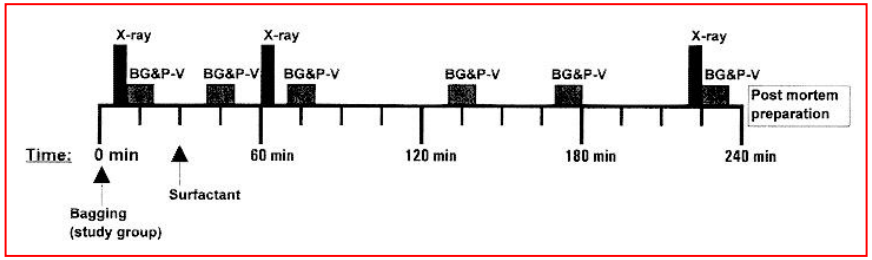
Vte (range) ml/Kg	5.2 (0.2-6.0)	4.6 p=NS
ECO2 (range) mmHg	16.0 (4-25)	4.0 p=NS

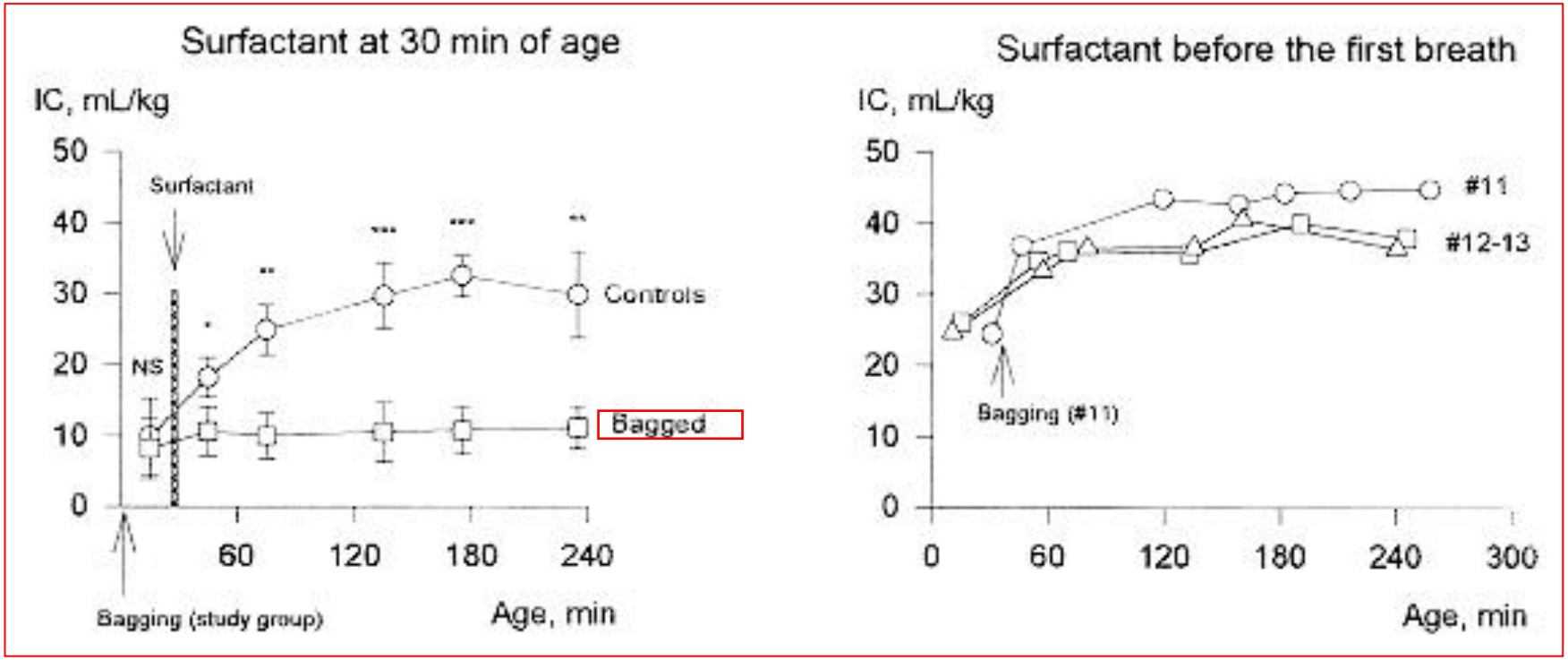
van Vonderen JJ, *et al. Arch Dis Child Fetal Neonatal Ed* 2015;**0**:F1–F5.

Manual Ventilation with a Few Large Breaths at Birth Compromises the Therapeutic Effect of Subsequent Surfactant Replacement in Immature Lambs

Lars J Björklund, Jonas Ingimarsson, Tore Curstedt, Joseph John, Bengt Robertson, Olof Werner and Carsten T

Pediatric Research (1997) 42, 348–355





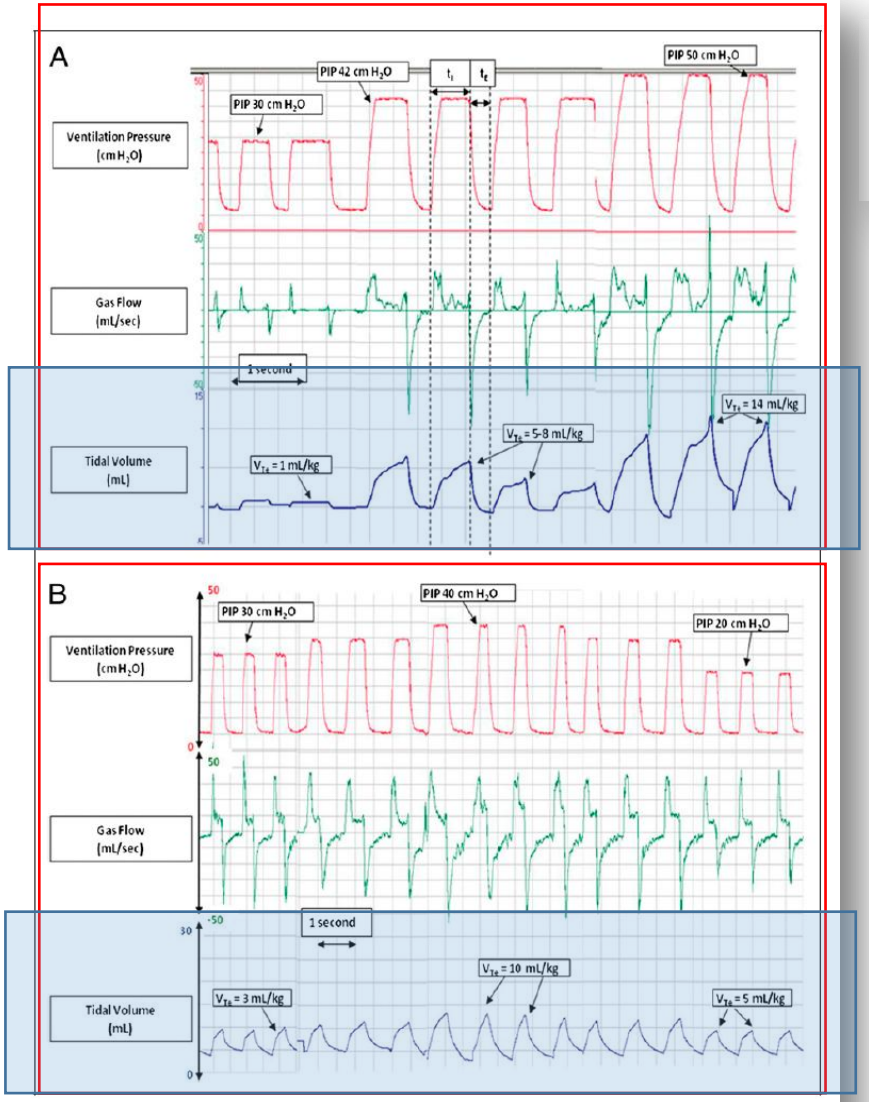


Figure 2. In panel A, the clinical team is guiding positive pressure ventilation by observing chest rise compared with panel B where a respiratory function monitor is used to guide expired tidal volume (V_{Te}) delivery. Initially, no chest rise is observed, the inflation and expiratory flow curves are small, and the measured V_{Te} is ~1 mL/kg. The clinical team is increasing the peak inflation pressure (PIP) to 42 cm H_2O, which results in an increase in V_{Te} to 5 to 8 mL/kg; however, there was still no chest rise visible. The clinical team continued to increase the PIP to 50 cm H_2O PIP, which resulted in an increase of V_{Te} to 14 mL/kg and visible chest rise. In comparison, in B, the initial V_{Te} was 3 mL/kg. After an increase in PIP, V_{Te} increased to 10 mL/kg. After the clinical team recognized the large V_{Te}, the PIP was reduced to 20 cm H_2O, which resulted in a decrease in the delivered V_{Te} to ~5 mL/kg.

Improving Assessment During Noninvasive Ventilation in the Delivery Room
Gianluca Lista, Georg M. Schmölzer and Colm P.F. O'Donnell
Neoreviews 2012;13;e364
DOI: 10.1542/neo.13-6-e364

Respiratory Function Monitor (RFM)

Table 2. **Pitfalls During Noninvasive Ventilation**

Optimizing face mask hold and position (mask leak) (20)(24)(27)
Airway obstruction (20)(23)
Tidal volume delivery (19)(21)(24)(25)(26)
Spontaneous breathing (27)(28)(29)
Ventilation rate (27)
Inflation time and expiratory time (27)
Correct endotracheal tube placement and tube size (27)

PIP (cmH2O)
24

PEEP (cmH2O)
2

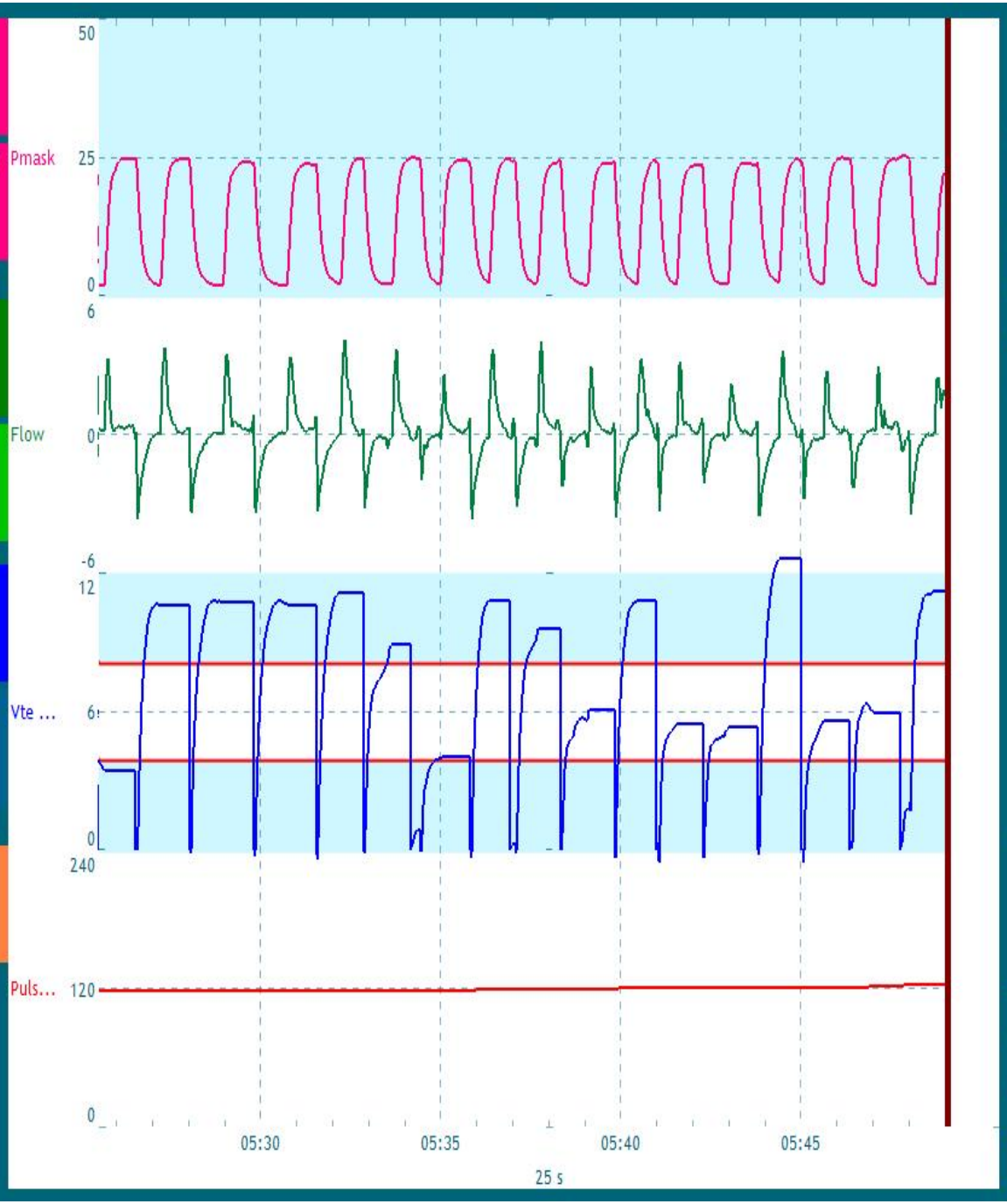
Flow (L/min)
1,4

RR (BrPM)
34

Vte (mL/kg)
5,9

Vti (mL/kg)
8,3

Leak (%)
28



Cursor: 0:00:00

- 0:30 | + 0:30 | Repeat

SpO2
51 %

Pulse Rate
123 BPM

Inspired Oxygen
64,0 %

Start | Stop

100% | 200% | 500% | Rec

05:48 | << Back

ald

Respiratory Function Monitor Guidance of Mask Ventilation in the Delivery Room: A Feasibility Study

Georg M. Schmölzer, MD, PhD[1,2,3,4], Colin J. Morley, MD[1,3,5], Connie Wong, MBA[1], Jennifer A. Dawson PhD,[1,3,5], Camille Omar F. Kamlin, DMedSci[1], Susan M. Donath, MA[3,5], Stuart B. Hooper, PhD[2], and Peter G. Davis, MD[1,3,5]

THE JOURNAL OF PEDIATRICS • www.jpeds.com 2012 Vol. 160, No. 3

Table III. DR interventions

	RFM visible (n = 26)	RFM masked (n = 23)	*P* value
Time PPV started after birth, seconds, median (IQR)	51 (38-68)	52 (43-80)	.49
Duration of PPV, seconds, median (IQR)	207 (97-240)	125 (95-258)	.50
CPAP, n (%)	19 (73)%	10 (43)%	.035*
Time CPAP started after birth, seconds, median (IQR)	273 (167-328)	221 (142-247)	.23
Endotracheal intubation, n (%)	7 (27)%	13 (54)%	.035*
Surfactant administration, n (%)	4 (15)%	5 (21)%	.57
Oxygen administration, n (%)	16 (61)%	20 (87)%	.044*
Time oxygen started after birth, seconds, median (IQR)	264 (178-301)	292 (169-303)	.88

*A *P* value of <.05 was considered statistically significant.

Secondary Outcome Measures

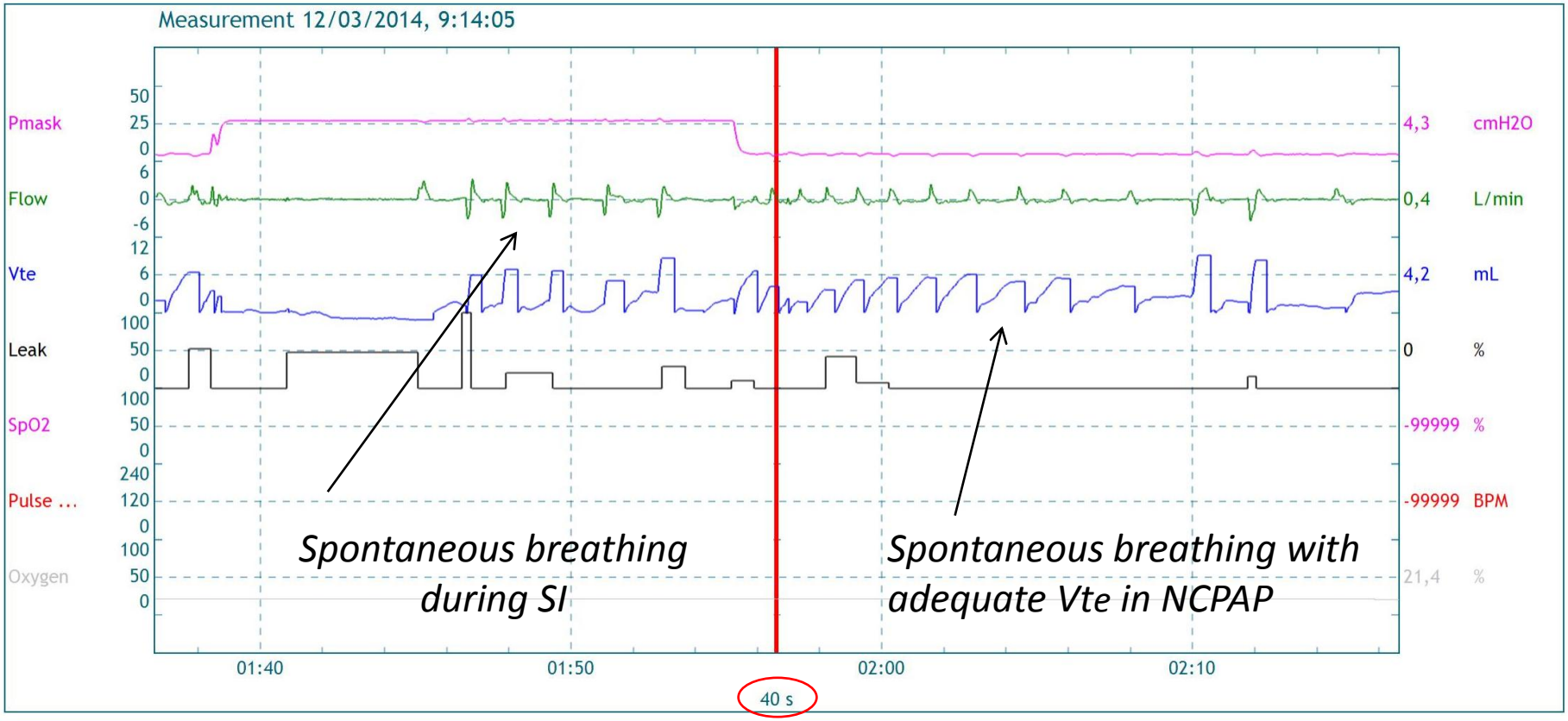
The percentage of infants receiving oxygen was 61% in the RFM visible group and 87% in the RFM masked group ($P = .044$). Significantly more infants were admitted to the NICU while receiving CPAP in the RFM visible group (73% vs 43%; $P = .035$). Intubation in the DR was done in 27% of the RFM visible group and in 57% of the RFM masked group ($P = .035$) (Table III). No infant received cardiac compressions or adrenaline in the DR.

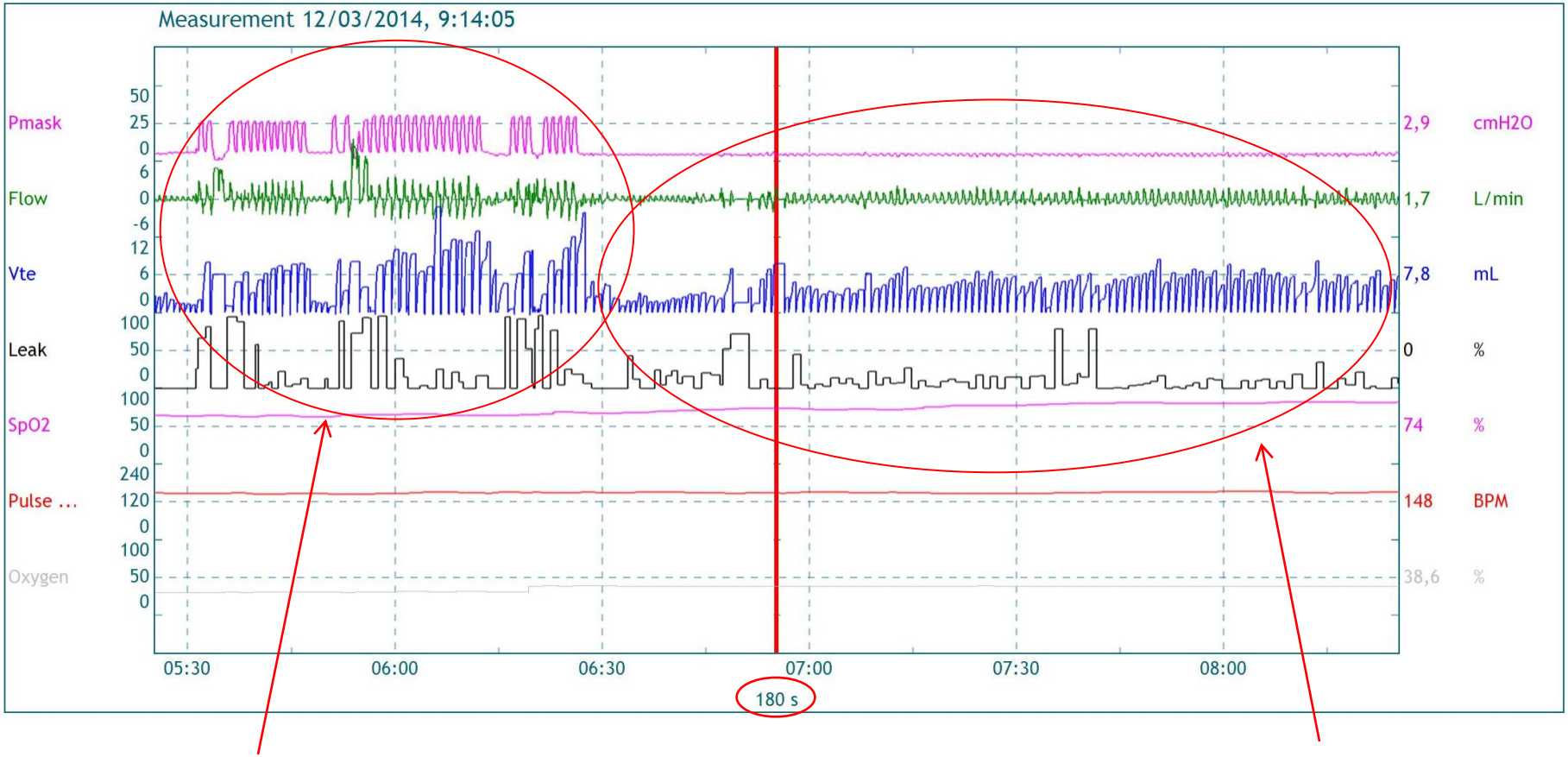
CPAP and ELBW infant

To intubate or not—that is the question: continuous positive airway pressure versus surfactant and extremely low birthweight infants

N Finer

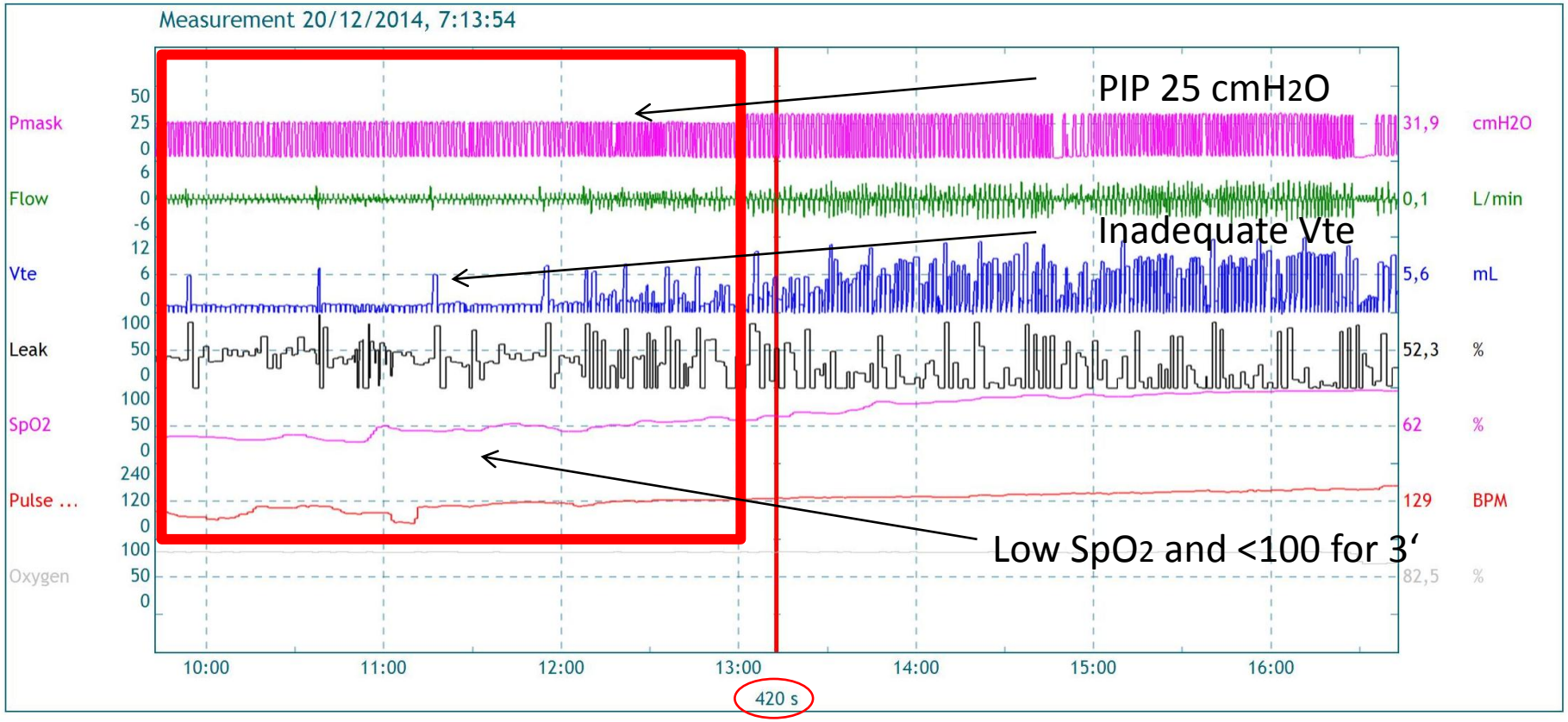
Do we really understand the **efficacy of spontaneous breathing** only supported by n-CPAP in the DR ? **When we can decide that mask ventilation is not adequate and decide to intubate** the newborn in DR?


Measurement 12/03/2014, 9:14:05
Pmask
Flow
Vte
Leak
SpO2
Pulse ...
Oxygen
4,3 cmH2O
0,4 L/min
4,2 mL
0 %
-99999 %
-99999 BPM
21,4 %
01:40
01:50
02:00
02:10
40 s
Spontaneous breathing during SI
Spontaneous breathing with adequate Vte in NCPAP

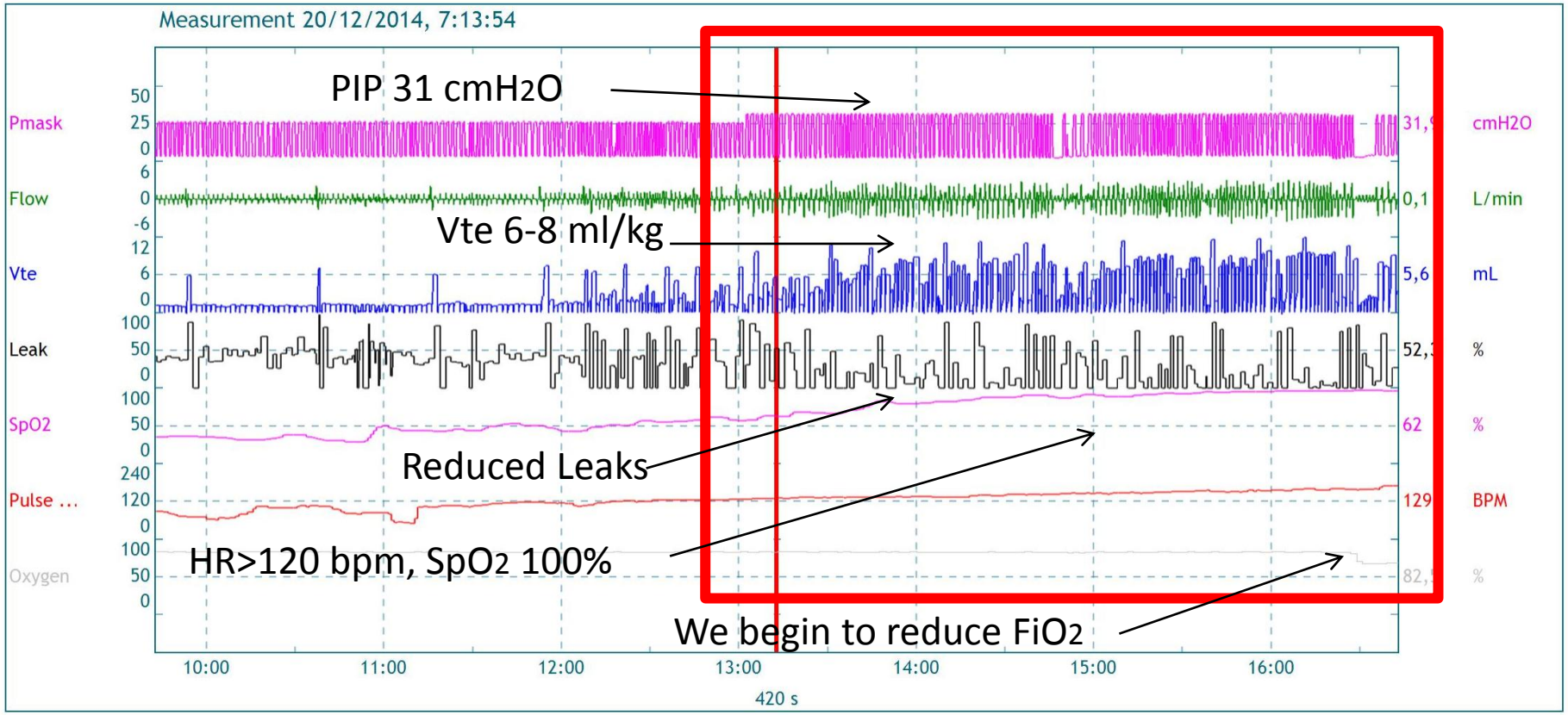


In course of PPV: at first <u>adequate Vte</u> then <u>Vte too much higher</u> after increasing of PIP level

In course of spontaneous breathing only suported by NCPAP, <u>low Vte at first, then adequate</u>. Significative reduction of mask leaks



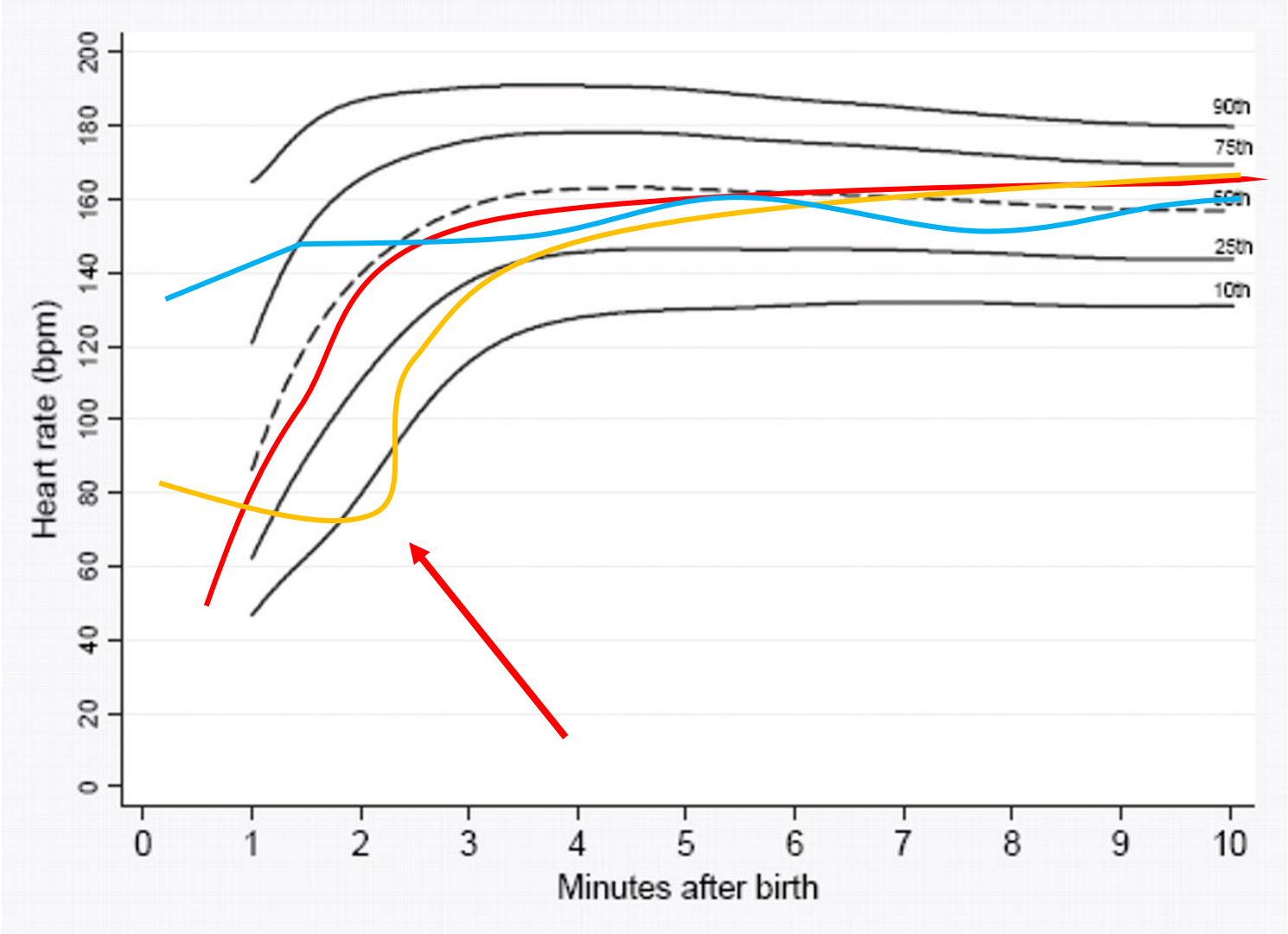
Have we….. to intubate the infant ?

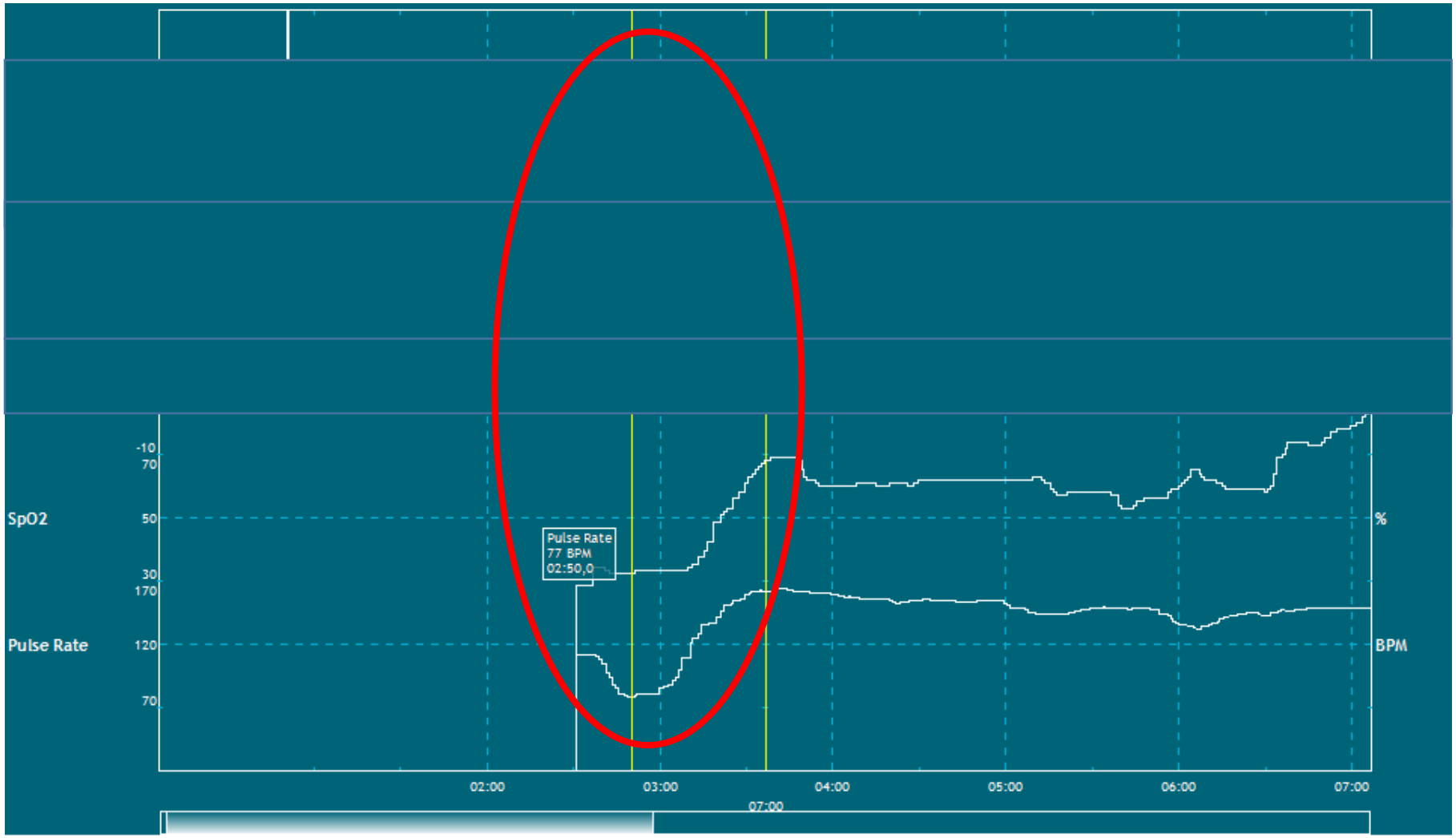


Using RFM, we can check in «real time» the Vte generated and so adjust PIP level and decide if the infants really needs ……to be intubated or not in the DR

Effects of mask PPV on HR and SpO_2 during DR stabilization of bradycardic preterm infants: an RFM analysis

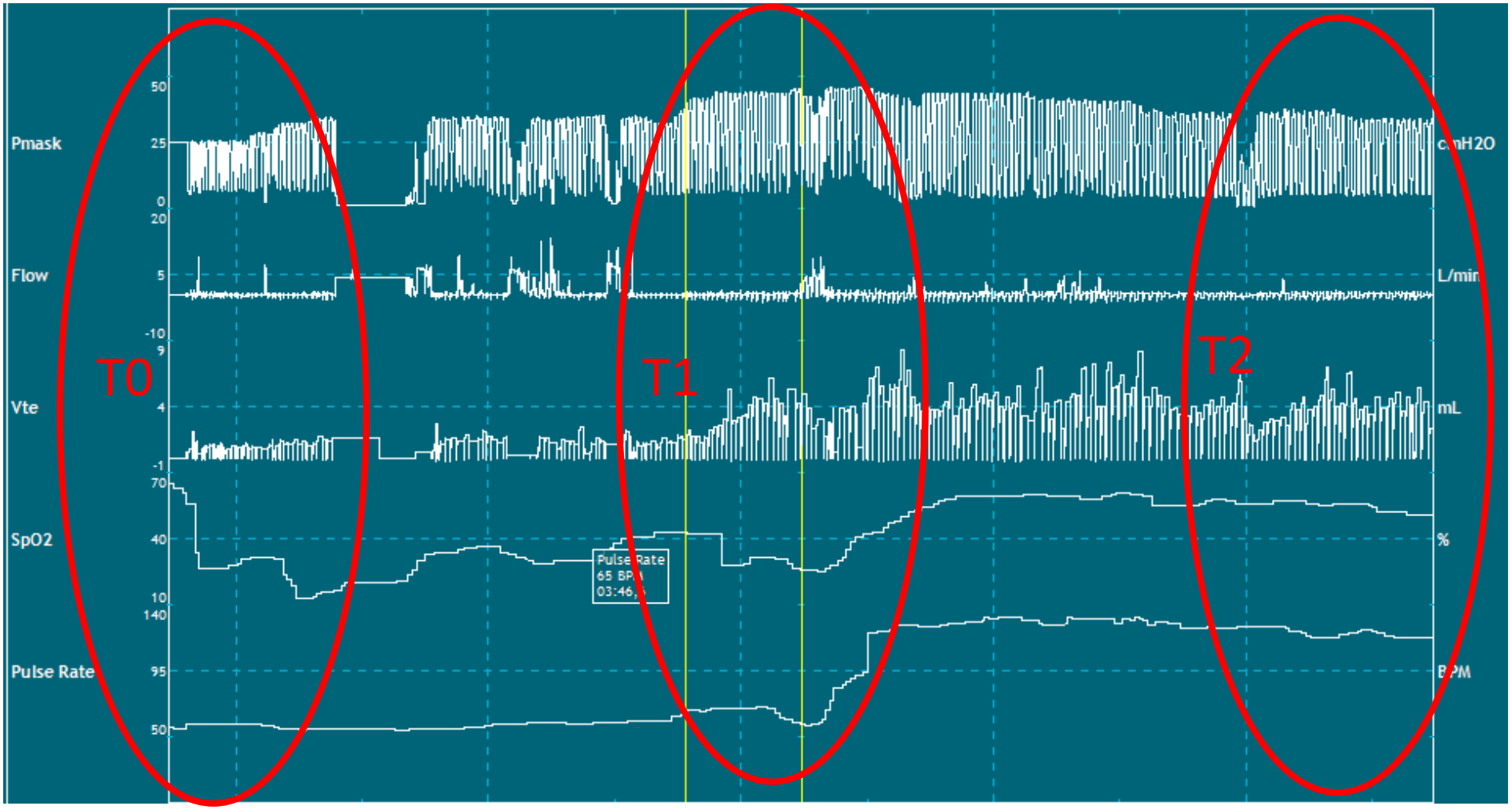
Francesco Cavigioli MD and Gianluca Lista MD PhD
V.Buzzi Children's Hospital
San Francisco May 11th 2017


Heart rate (bpm)
0
20
40
60
80
100
120
140
160
180
200
90th
75th
50th
25th
10th
0
1
2
3
4
5
6
7
8
9
10
Minutes after birth


SpO2
-10
70
50
30
%
Pulse Rate
170
120
70
BPM
Pulse Rate
77 BPM
02:50,0
02:00
03:00
04:00
05:00
06:00
07:00
07:00

METHODS

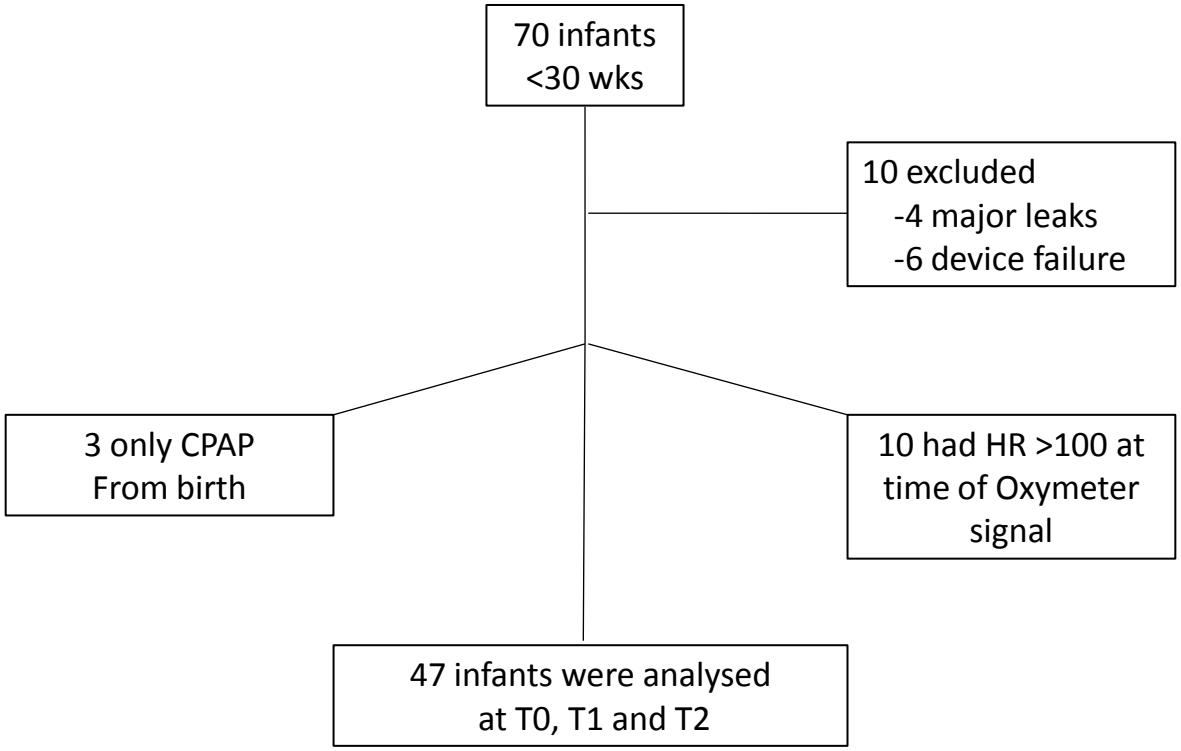
- **Retrospective observational study** approved by local IRB
- **Recordings were reviewed on a breath by breath analysis** including Pressure, Flow, Vte, HR, SpO_2 and FiO_2 signals
- **Three different moments of the stabilization process** were identified and **10 leaks free ventilations in each period** were studied :
  - **T0** : First 10 ventilations at **PPV start**
  - **T1**: 10 ventilations around the moment of **HR raise over 100 bpm**
  - **T2: Last period of PPV before moving to CPAP or before stopping recording** (max 10 minutes, could be mask ventilation or ET- ventilation in intubated infants)


Pmask
50
25
0
cmH2O
Flow
20
5
-10
L/min
Vte
9
4
-1
mL
SpO2
70
40
10
%
Pulse Rate
140
95
50
BPM
Pulse Rate
65 BPM
03:46
T0
T1
T2

Elegibility criteria

- **Preterm infants <30 wks' GA** born between jan 2014 and jan 2017 in Milan at "V.Buzzi Children's Hospital" who were recorded with an RFM during early stabilization with T-piece and mask in the first minutes of life.

- **Showing HR < 100 bpm when first oxymetry signal appeared**



N	GA median (IQR)	Birth Weight median (IQR)	Cesarean section (%)	Twins (%)	Prenatal steroids (%)
47	27 (25^{+4}-28^{+1}) wks	789 (699-1025) g	39/47 (82%)	17/47 (36%)	44/47 (93%)

Objective

- To analyze correlations between:
  - **ROSC** (return of spontaneous circulation intended as Pulse-oxymetry HR and SpO_2 data) in the first minutes of life and
  - **Ventilation data** (pressures and tidal volumes delivered in course of PPV, lung dynamic compliance).

Main results

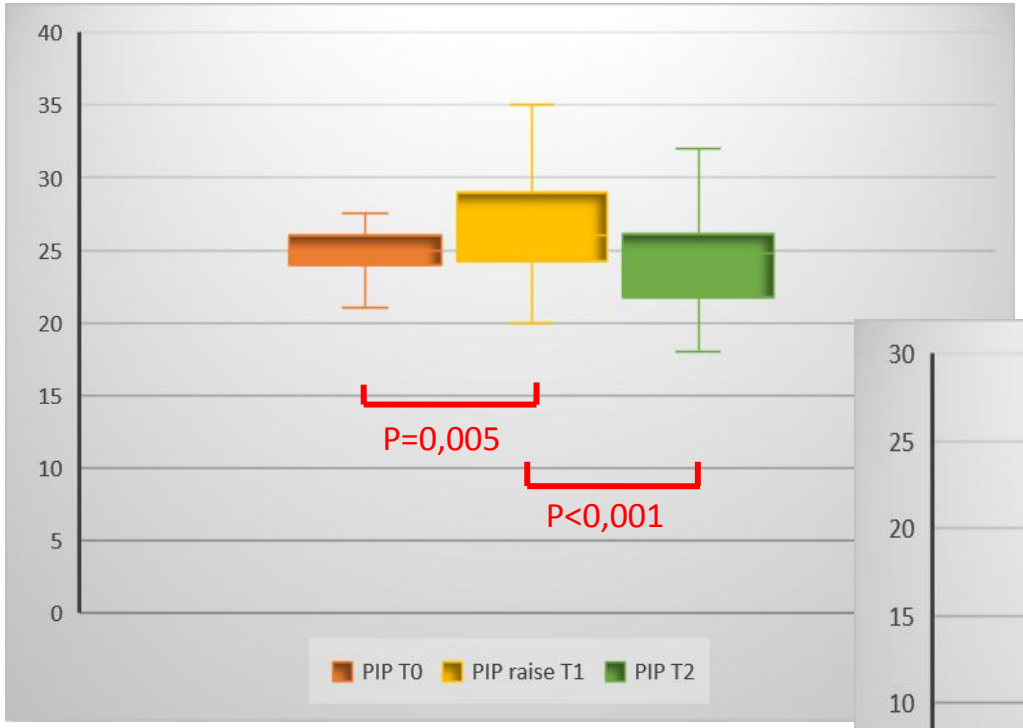
Parameter	Median IQR
Oximetry signal (sec)	58.5 (44 – 76)
Initial HR (bpm)	67 (54 – 84)
Initial SpO2 (%)	29.5 (15 – 44.5)
Time of PPV start (sec)	64 (46-111)
HR > 100 bpm (sec)	166 (116-236)
SpO2 > 75 % (sec)	272 (229 – 323)
DR intubation	9/47 (19%)
CPAP in DR	36/47 (76,5%)
Time of CPAP start (sec)	288 (238-432)
VM < 72 h	15/47 (42%)
Surfactant given NICU	32/47 (68%)
Mortality	11/47 (23%)

T0

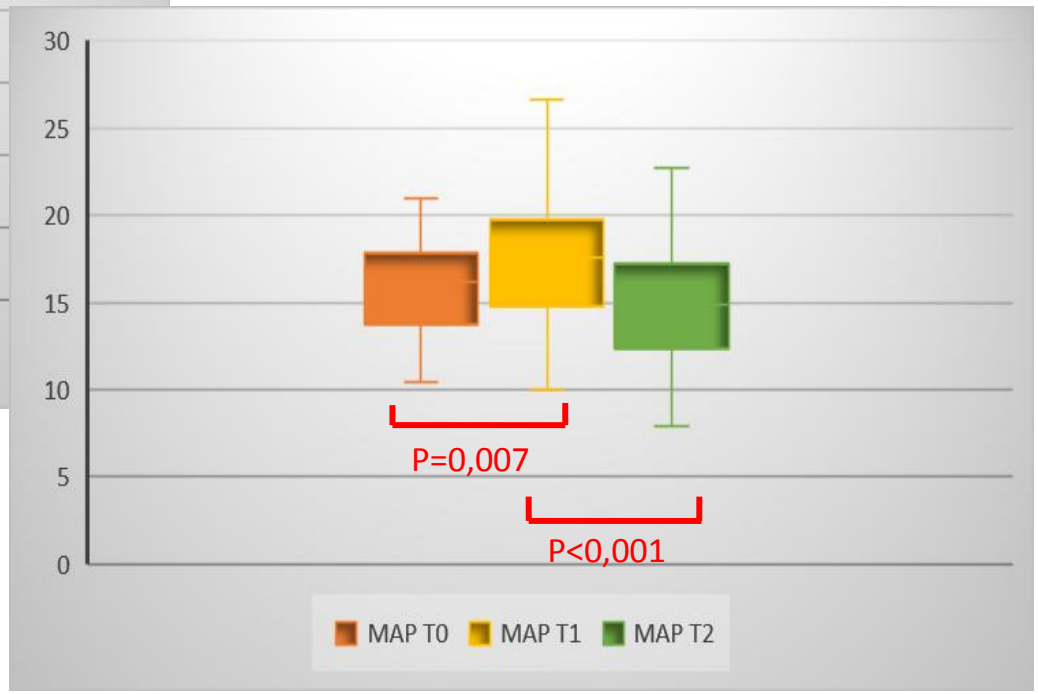
T1

T2

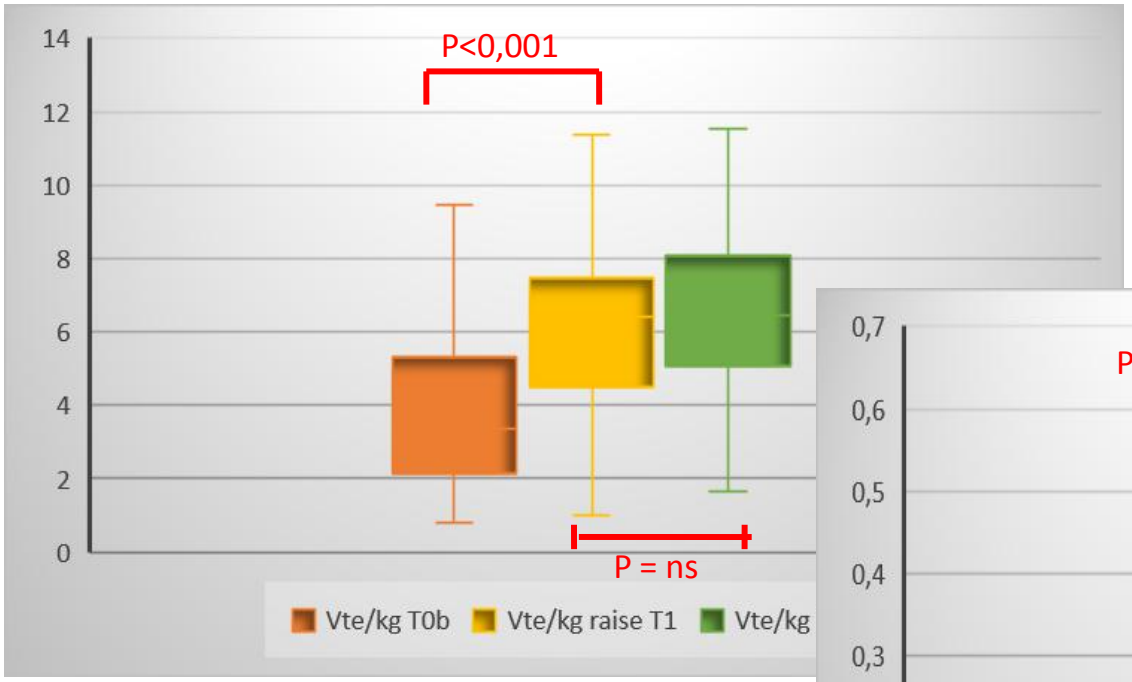
Unpublished data



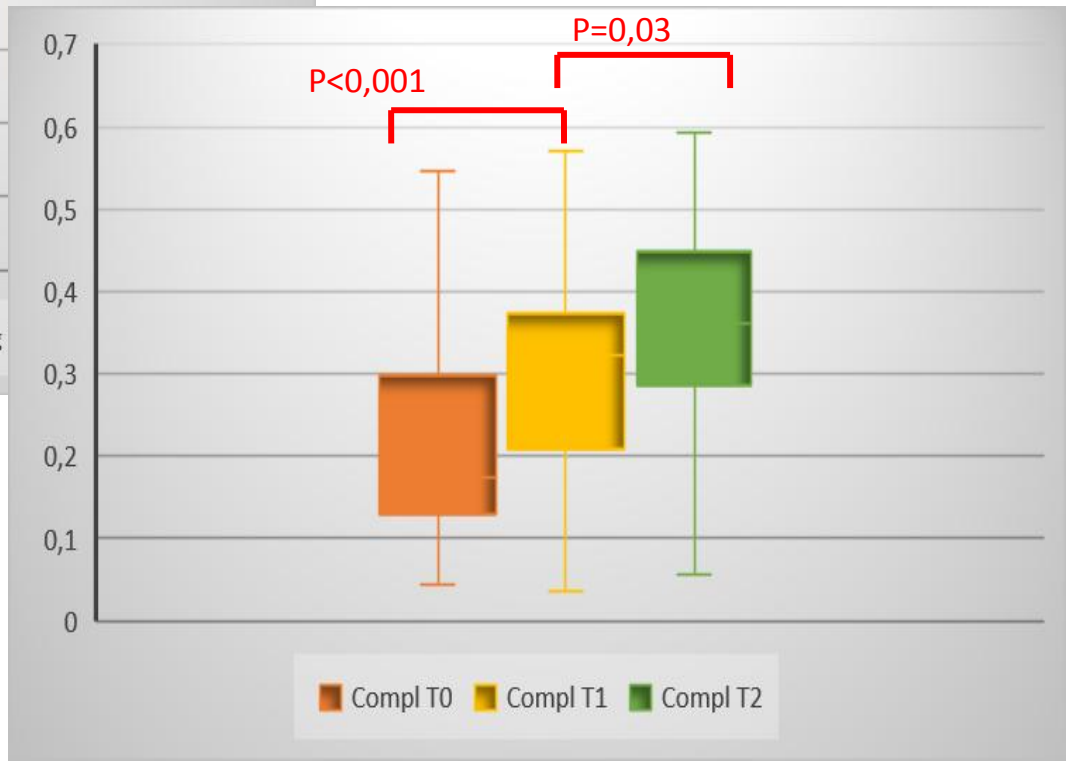
T	PIP (median IQR) cmH2O
T0	25 (22.7 - 26)
T1	26 (24.7 - 29)
T2	25 (22.5 - 26)



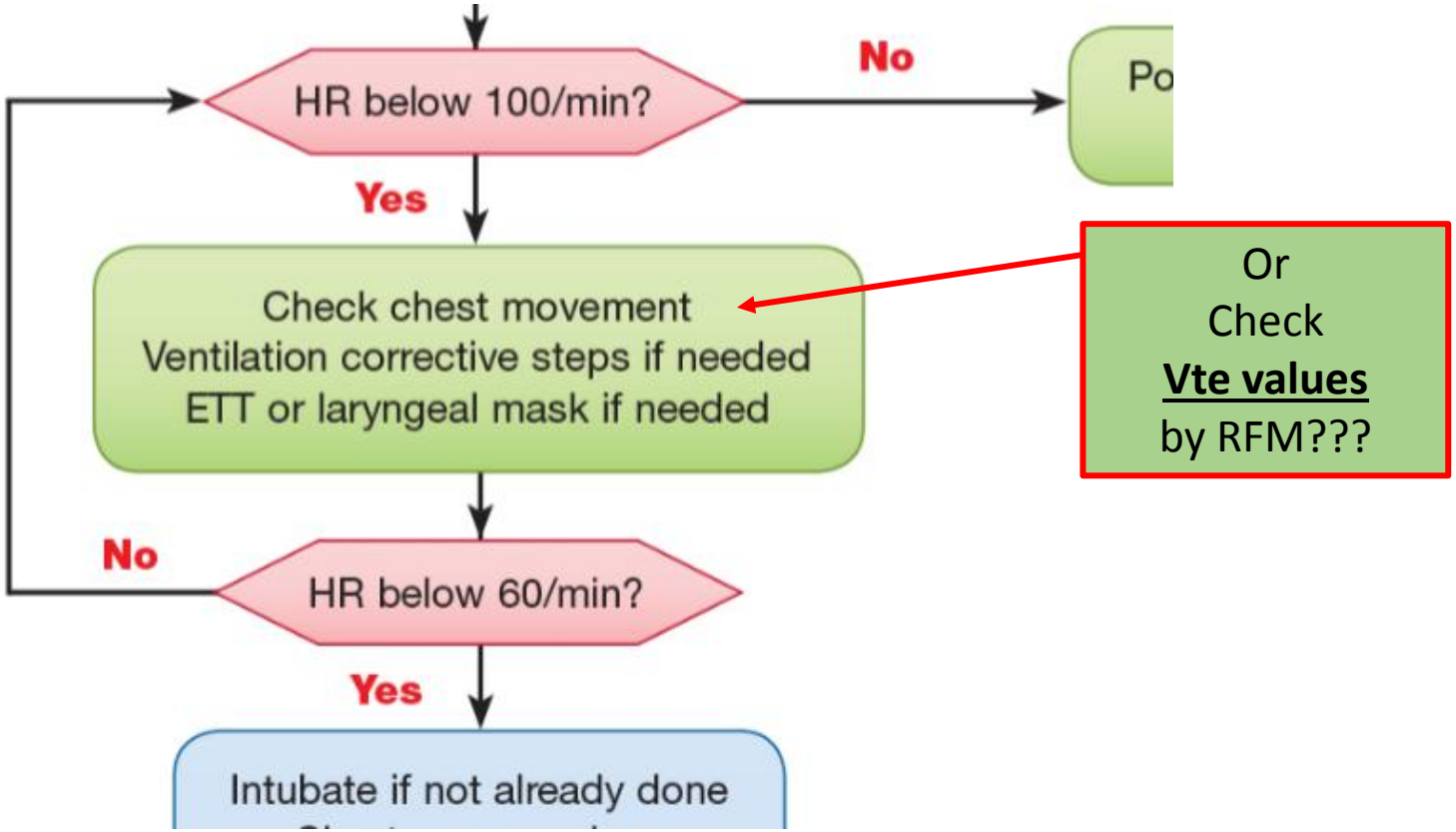
T	MAP (median IQR) cmH2O
T0	16.2 (13.7 – 17.7)
T1	17.5 (14.5 – 19.8)
T2	14.9 (12.4 – 17.2)



T	Vte/kg (median IQR) ml
T0	2.7 (1.9 - 4.7)
T1	6.4 (4.4 - 7.4)
T2	6.6 (5.3 - 8.2)



T	Cdyn (median IQR) ml/cmH2O/Kg
T0	0.16 (0.11 – 0.23)
T1	0.32 (0.20 – 0.37)
T2	0.37 (0.29 – 0.45)



Neonatal resuscitation algorithm. Wyckoff MH et al Circulation 2015; 132:S543-S560

Conclusions

1. Adequate ventilation of the lung and initial recruitment seems to be the key point for ROSC
2. Initial assessment with an RFM when delivering PPV with a face mask could help the resuscitating team in their decisions ….to maintain the baby in CPAP or intubate and start MV .

Original article

Auditing documentation on delivery room management using video and physiological recordings

K Schilleman, R S Witlox, J J van Vonderen, E Roegholt, F J Walther, A B te Pas

Conclusions Accurate and complete documentation of neonatal resuscitation continues to be a challenge. Recordings of physiological parameters and video imaging can improve documentation by providing detailed information.

Respirator
Type o
Sustained inflati
Consecutive inflati
Applied
Pressures
Effect o
Effect on
Effect on s
Duration o

Schilleman K, *et al*. *Arch Dis Child Fetal Neonatal Ed* 2014;**99**:F485–F490. doi:10.1136/archdischild-2014-306261

RFM: practice points

- RFM+ videorecording could be used during mannequin based neonatal training program or as "audit" with the resuscitation team to teach
- 1) correct mask hold to reduce leak,
- 2) assessment of PIP/PEEP and
- 3) appropriate Vt

- RFM during resuscitation can provide continuous information in "real time" about:
- 1) Vte
- 2) mask or EET leak
- 3) airway or EET obstruction,
- 4) the spontaneous breathing patterns, Vte and interaction with inflations like exhaled CO_2 amount (…….decision for intubation ?)

- Limitations : RFM only displays the waves and data and not interpretation of the signals or a diagnosis. Neonatologists need to be trained in its using. At beginning it is not easy to use by alone during resuscitation (learning curve)

Respiratory Function Monitoring in the DR…is feasible, but this technology merits further investigations.