Respiratory function monitoring in the delivery room

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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.
Mechanical Ventilation and Bronchopulmonary Dysplasia

Martin Keszler, MD\textsuperscript{a,*}, Guilherme Sant’Anna, MD, PhD, FRCP\textsuperscript{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.\textsuperscript{1} Among survivors, almost 95% were invasively ventilated at some point during their hospital stay. In the Surfactant, Positive Pressure, and Oxygenation Randomized Trial

David G. Sweet a, Virgilio Candielli 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.
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 waveform 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.

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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\textsubscript{2}O via mask or nasal prongs (A1). Gentle positive pressure lung inflations using about 20–25 cm H\textsubscript{2}O 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).
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 to term infants was previously measured to be approximately 12 mL/kg on average. 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. 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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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
  - SpO2
  - FiO2
  - Vt

Videorecording
Review

Face mask ventilation – the dos and don’ts

Fiona E. Wood a, *, Colin J. Morley b

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b University of Cambridge, Department of Obstetrics and Gynaecology, Addenbrooke’s Hospital, Cambridge CB2 0QQ, UK

SUMMARY

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.

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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.
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.
Leaks

No leaks

Leaks

Correction of mask position

60 s
A respiratory function monitor improves mask ventilation

F E Wood, C J Morley, J A Dawson, P G Davis

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. 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)%. Operators were unaware of the magnitude of the leak. We showed that teaching techniques of holding face masks reduced the leak to 33 (26)%.

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 H₂O and a positive end-expiratory pressure (PEEP) of 5 cm H₂O 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 Schmölder,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 Davis1,3,5


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.
Monitoring lung aeration

- Respiratory Function Monitor (RFM)
- T-piece resuscitator
- Volumetric CO₂ monitor
- Respiratory Inductance Plethysmography (RIP)
Monitoring Lung Aeration during Respiratory Support in Preterm Infants at Birth

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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 (VT) to achieve gas exchange.

Objective: The aim of our pilot study was to measure changes in exhaled carbon dioxide (ECO₂), VT, and rate of carbon dioxide elimination (VCO₂) 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 VT delivery and ECO₂ continuously recorded using a sensor attached to the facemask.

Table 1. Demographics of study infants.

<table>
<thead>
<tr>
<th></th>
<th>CPAP group (n = 31)</th>
<th>PPV group (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (g)</td>
<td>1763±487</td>
<td>1357±709†</td>
</tr>
<tr>
<td>Gestational age (weeks)</td>
<td>31±2</td>
<td>29±3†</td>
</tr>
<tr>
<td>Male*</td>
<td>11 (35%)</td>
<td>7 (35%)</td>
</tr>
<tr>
<td>Antenatal steroids*</td>
<td>27 (87%)</td>
<td>12 (60%)¹</td>
</tr>
<tr>
<td>Cesarean section*</td>
<td>22 (71%)</td>
<td>13 (65%)</td>
</tr>
<tr>
<td>Apgar 1 minute*</td>
<td>6 (4-8)</td>
<td>4 (2-6)†</td>
</tr>
<tr>
<td>Apgar 5 minutes*</td>
<td>8 (7-8)</td>
<td>7 (5-8)†</td>
</tr>
<tr>
<td>Delayed cord clamping</td>
<td>18 (58%)</td>
<td>11 (55%)</td>
</tr>
</tbody>
</table>

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.
Fetal glottis is tonically adducted during apnea

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

Hooper S, gentle concession, partly modified
Evaluating Manual Inflations and Breathing during Mask Ventilation in Preterm Infants at Birth

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

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 ($R^2=0.052$).
Spontaneous breathing appears to play an important part in the success of ventilation given at birth.

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

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
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
Respiratory Function Monitor (RFM)

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 $\sim 1$ mL/kg. The clinical team is increasing the peak inflation pressure (PIP) to $42$ cm H$_2$O, 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$_2$O 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$_2$O, which resulted in a decrease in the delivered $V_{Te}$ to $\sim 5$ mL/kg.

Table 2. Pitfalls During Noninvasive Ventilation

- Optimizing face mask hold and position (mask leak) (20)(24)(27)
- Airway obstruction (20)(23)
- Spontaneous breathing (27)(28)(29)
- Ventilation rate (27)
- Inflation time and expiratory time (27)
- Correct endotracheal tube placement and tube size (27)
Respiratory Function Monitor Guidance of Mask Ventilation in the Delivery Room: A Feasibility Study

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


Table III. DR interventions

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

*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.
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?
Spontaneous breathing during SI

Spontaneous breathing with adequate Vte in NCPAP
In course of PPV: at first adequate \textit{Vte} then \textbf{Vte too much higher} after increasing of PIP level

In course of spontaneous breathing only supported by NCPAP, low \textit{Vte} at first, then adequate. Significant 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 11$^{th}$ 2017

5$^{th}$ Neonatal Resuscitation
Research Workshop
Napa Valley 2017
METHODS

• **Retrospective observational study** approved by local IRB

• **Recordings were reviewed on a breath by breath analysis** including Pressure, Flow, Vte, HR, SpO₂ and FiO₂ 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)
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**
70 infants <30 wks

10 excluded
- 4 major leaks
- 6 device failure

3 only CPAP From birth

10 had HR >100 at time of Oxymeter signal

47 infants were analysed at T0, T1 and T2

<table>
<thead>
<tr>
<th>N</th>
<th>GA median (IQR)</th>
<th>Birth Weight median (IQR)</th>
<th>Cesarean section (%)</th>
<th>Twins (%)</th>
<th>Prenatal steroids (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>27 (25.4-28.1) wks</td>
<td>789 (699-1025) g</td>
<td>39/47 (82%)</td>
<td>17/47 (36%)</td>
<td>44/47 (93%)</td>
</tr>
</tbody>
</table>
Objective

• To analyze correlations between:
  • **ROSC** (return of spontaneous circulation intended as Pulse-oxymetry HR and SpO₂ data) in the first minutes of life and
  • **Ventilation data** (pressures and tidal volumes delivered in course of PPV, lung dynamic compliance).
## Main results

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

Unpublished data
**P=0.005**

**P<0.001**

**T**

**T0**

**T1**

**T2**

**P=0.007**

**P<0.001**

**T**

**MAP (median IQR) cmH2O**

<table>
<thead>
<tr>
<th>T</th>
<th>MAP (median IQR) cmH2O</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>16.2 (13.7 – 17.7)</td>
</tr>
<tr>
<td>T1</td>
<td>17.5 (14.5 – 19.8)</td>
</tr>
<tr>
<td>T2</td>
<td>14.9 (12.4 – 17.2)</td>
</tr>
</tbody>
</table>

**T**

**PIP (median IQR) cmH2O**

<table>
<thead>
<tr>
<th>T</th>
<th>PIP (median IQR) cmH2O</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>25 (22.7 - 26)</td>
</tr>
<tr>
<td>T1</td>
<td>26 (24.7 - 29)</td>
</tr>
<tr>
<td>T2</td>
<td>25 (22.5 - 26)</td>
</tr>
</tbody>
</table>
### Vte/kg (median IQR) ml

<table>
<thead>
<tr>
<th>T</th>
<th>Vte/kg (median IQR) ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>2.7 (1.9 - 4.7)</td>
</tr>
<tr>
<td>T1</td>
<td>6.4 (4.4 - 7.4)</td>
</tr>
<tr>
<td>T2</td>
<td>6.6 (5.3 - 8.2)</td>
</tr>
</tbody>
</table>

### Cdyn (median IQR) ml/cmH2O/Kg

<table>
<thead>
<tr>
<th>T</th>
<th>Cdyn (median IQR) ml/cmH2O/Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>0.16 (0.11 – 0.23)</td>
</tr>
<tr>
<td>T1</td>
<td>0.32 (0.20 – 0.37)</td>
</tr>
<tr>
<td>T2</td>
<td>0.37 (0.29 – 0.45)</td>
</tr>
</tbody>
</table>
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.
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.
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 CO2 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.