



Volume Guarantee

Initiation and ongoing clinical management of an infant supported by Volume Guarantee – A Case Study

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The patient is a premature female infant born at 25 4/7 weeks, weighing 452 grams, following premature rupture of membranes at a community hospital. She was supported briefly in the delivery room with CPAP following surfactant administration, and was transferred to a level IV NICU for further care on the second day of life. The infant arrived at the hospital with the neonatal transport team on CPAP with a pressure of 8 cm H₂O and a set FiO₂ of 0.7. The infant was in distress and presented with the following: nasal flaring, intercostal and substernal retractions, and occasional apneic episodes that responded to intermittent tactile stimulation. The chest x-ray showed diffuse bilateral infiltrates and profound hypoinflation, consistent with Respiratory Distress Syndrome (RDS).

Due to the patient's deteriorating respiratory status on high CPAP settings, Non-Invasive Ventilation (NIV) was initiated using the Dräger Babylog VN500.

Initial Settings

Application Mode	NIV
Mode	PC-CMV
PIP	20 cm H ₂ O
PEEP	6 cm H ₂ O
Respiratory Rate	20/min
Ti	0.4 s
FiO₂	0.6

Initial arterial blood gas via Umbilical Artery Catheter

pH	7.28
PaCO₂	55 mmHG
PaO₂	55 mmHG
HCO₃	19 mmHG

NIV resulted in reduced work of breathing and avoided intubation for this patient. The patient was initially asynchronous with the non-invasive PC-CMV¹ breaths, so the respiratory rate (RR) was adjusted to match every other spontaneous effort being made by the patient (Figure 1).

¹ Pressure Control - Continuous Mandatory Ventilation

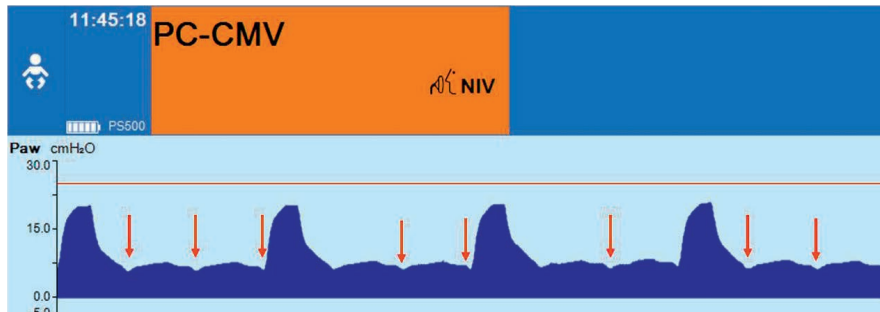


Figure 1: Graphical representation of airway pressure in the patient during NIV with the Babylog VN500

The red arrows in Figure 1 indicate small depressions in the baseline pressure where the patient is making an inspiratory effort. Adjusting the rate to provide fully supported breaths on every other spontaneous effort was useful for improving synchrony in this patient.

The patient failed NIV after 10 hours due to apnea, desaturations, and bradycardia. The chest x-ray (Figure 2) after intubation revealed diffuse bilateral infiltrates consistent with RDS. The patient was given 2 mL/kg Curosurf® for poor compliance (0.5 mL/cm H₂O), refractory hypoxemia, and radiographic evidence of pulmonary atelectasis.

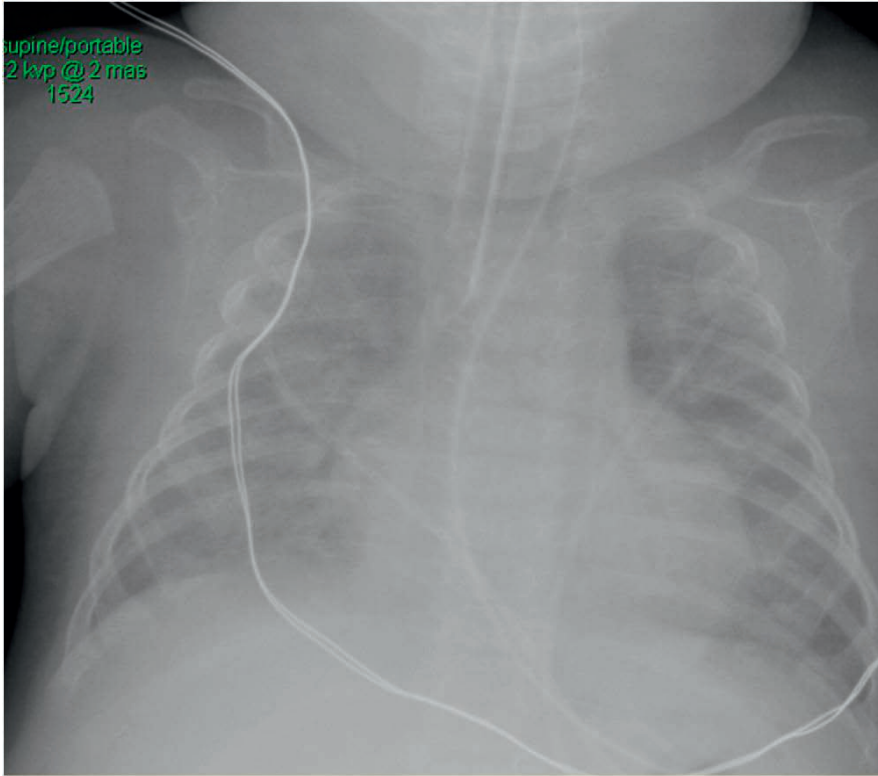


Figure 2: X-ray after intubation

The application mode was changed to “tube” for invasive ventilation. The physician ordered PC-AC² with Volume Guarantee (VG) with the following settings: tidal volume (VT) of 4 mL/kg, PEEP of 8 cm H₂O, an inspiratory time (Ti) of 0.3 s, RR 50 /min. The patient was spontaneously assisting all breaths and was breathing at a rate of 70 /min. The transcutaneous CO₂ levels were 75 mmHg and these values correlated well with the arterial CO₂ levels observed with the last blood gas on nasal CPAP. Upon the physician's request, the Respiratory Therapist (RT) increased the VT to 5 mL/kg to account for the instrumental deadspace of the flow sensor and ET tube. The respiratory rate and CO₂ levels decreased in response to this change and the patient appeared comfortable.

Following this change, an audible ET tube leak could be heard. The ventilator was registering a 50-60 percent leak and an alarm on the ventilator began reading "VT low". This problem was remedied by changing the Pmax setting from 25 to 30 cm H₂O in order to provide enough pressure to allow the tidal volume to be delivered.

Twenty-four hours later, the patient's lung mechanics improved as reflected by lower Peak Inspiratory Pressure (PIP) values. However, the bedside Registered Nurse (RN) expressed concerns that the patient appeared tachypneic and had low PIP values. The bedside RT assured the nurse that this was related to the nursing care and usually the PIP values returned to normal after care was rendered. The RT presented a trend of the pressures and volumes (Figure 3) to the RN. She was then assured that this was a normal function of the ventilator and may be appropriate so that the patient isn't receiving too much pressure and volume during periods of anxiety.

² Pressure Control - Assist Control



Figure 3: Trend of tidal volume and airway pressure

The trending of pressure and volume show reduced inspiratory pressures due to increased volumes during periods of nursing care (red arrows). The patient's efforts are reduced after nursing care, resulting in smaller volumes and higher PIP values.

A month later, the infant was still supported with the Babylog VN500 in the PC-AC mode with Volume Guarantee activated. The infant gradually started showing signs of increased work of breathing on the ventilator and increased FiO₂ requirement following upsizing of the ET tube.

Settings

Application Mode	Tube
Mode	PC-AC with VG
PIP	7 cm H ₂ O
Vt	14.4 mL (set) 17.5 mL (measured)
PEEP	6 cm H ₂ O
Respiratory Rate	20/min
Ti	0.30 s
FiO₂	0.29

Venous Blood Gas

pH	7.23
PaCO ₂	68 mmHG
PaO ₂	23 mmHG
HCO ₃	29 mmHG

Airway graphics revealed consistently low PIP values with tidal volumes greater than that set on the ventilator (Figure 4A). The chest x-ray showed low lung volumes with increasing atelectasis and air bronchograms (Figure 4B) from the previous exam. The patient developed retractions, nasal flaring, and SpO₂ 78-89 percent. Breath sounds were reduced in the bases with fine inspiratory crackles throughout.

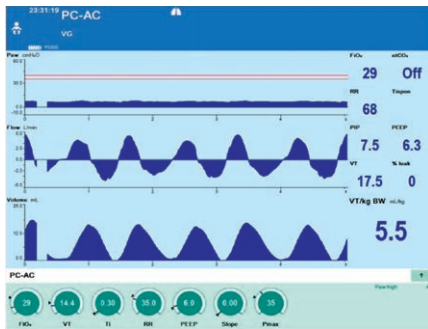


Figure 4A: Inadequate support during PC-AC

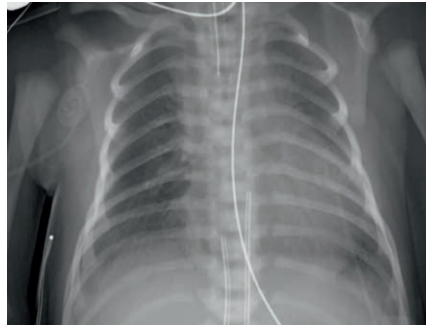


Figure 4B: Strong infiltration constant with atelectasis

Based on the clinical deterioration, the RT chose to assess the appropriateness of the tidal volume setting. The attending neonatologist wanted to place the patient in PC-AC without Volume Guarantee, so that the patient could get a higher level of support. During this time, the NICU team discovered that the dose-calculated weight in the ventilator hadn't been updated in over a month. When the new weight was entered, it became obvious that the patient was only receiving a tidal volume ~ 3.5 mL/kg. This prompted the team to increase the set tidal volume targeted from 14 to 19 mL. This resulted in an immediate reduction in the observed high levels of work of breathing and increased in PIP values (Figure 5A) as well as radiographic improvement in lung inflation (Figure 5B).

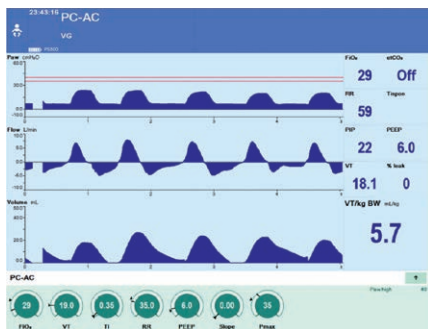


Figure 5A: Airway graphic following setting change

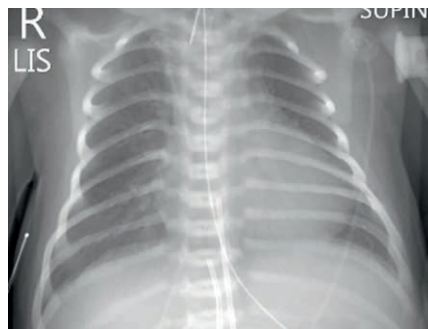


Figure 5B: X-ray following setting change

A week later the PIP values were again reduced to only 1 cm H₂O above the PEEP level during PC-AC with Volume Guarantee. However, with the exception of this time, the patient had normal breathing and acceptable gas exchange. Based on this, the patient was extubated to non-invasive CPAP. Subsequently, five days later, the patient was transferred home utilizing oxygen therapy at 0.5 L/min via nasal cannula.



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