

# To Swim with the Tide: High Tidal Volume, Low Rate Ventilation in a Neonate with Respiratory Failure Due to Severe Broncho-Pulmonary Dysplasia

By Shabih Manzar, MD; Liaqat H. Khan, MD

The infant was the second of the twins, born to a 21-year old gravida 2, para 1. All antenatal labs including HIV, Hepatitis B, and rapid plasma reagin were negative. There was no history of sexually transmitted diseases. Pregnancy was complicated by preterm labor and she delivered twins at 24 weeks of gestation. The mother received two doses of betamethasone prior to delivery. Apgar scores were 4 and 7 at one and five minutes respectively. The infant's birth weight was 543 grams, head circumference 22 centimeters, and length of 32 centimeters.

On admission to the Neonatal Intensive Care Unit (NICU), the physical examination was normal for gestational age. A septic work-up was done including complete blood count and blood culture and the infant was started on antibiotics. Infant was already intubated in the delivery room and was placed on ventilator in NICU. Chest X-ray was compatible with Respiratory Distress Syndrome (RDS). Surfactant was given via endotracheal tube. Blood gas on admission was pH of 7.44 pCO<sub>2</sub> of 34 PO<sub>2</sub> of 61 and HCO<sub>3</sub> of 24 on 60% FiO<sub>2</sub>. The infant

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was started on total parental nutrition. Feeds were started on Day of Life (DOL) 2, and gradually advanced to full feeds. By day 24, the infant was on full enteral feeds. The infant had multiple head ultrasounds, all showed no signs of bleed or



Figure 1. Chest X-ray at 120 Days of Life.



Figure 2. Chest X-ray at 1 Week after Intervention.

periventricular leukomalacia. MRI brain did not show any congenital anomalies. An echocardiogram done at Day of Life 7 showed a small Patent Ductus Arteriosus (PDA), which was managed conservatively per our NICU policy. A follow-up serial echocardiogram performed to screen for pulmonary

hypertension, showed trivial tricuspid regurgitation with gradient range 23-33 mm Hg, normal size right atrium, and normal right ventricular function.

The infant's respiratory status continued to deteriorate, and he failed several extubation attempts. At 120 DOL, the

infant remained on a very high ventilator settings (Oscillator = Fraction Inspired oxygen 100%, Mean Airway Pressure = 24, Amplitude = 60 and Frequency = 5), and was unable to wean. Also, he was noted to have air hunger, and required an increase dose of sedation. The Chest X-ray is shown in Figure 1. Based on the article by Shepherd et al<sup>1</sup>, we decided to place the infant on high tidal volume low rate mode of ventilation. The infant tolerated that well, and was able to wean of FiO<sub>2</sub> to 45-50% within 48 hours. The follow-up Chest X-ray showed improvement in the lung fields (see Figure 1). At the time of this report, the infant is tolerating 30 calorie formula via orogastric tube and gaining weight (see Figure 2). The plan is to send him for tracheostomy and gastrostomy to Children's Hospital.

### Discussion

The definition of Bronchopulmonary Dysplasia (BPD) has evolved in recent years. For infants born at less than 32 weeks of gestation, who received supplemental oxygen for more than 28 days, are assessed at 36 weeks post-menstrual age (PMA). If the infant is in room air on 36 weeks PMA, the infant has mild BPD. If he/she is on less than 30% oxygen, he/she has moderate BPD, and if he/she is on greater than 30% O<sub>2</sub> or needing respiratory support, he/she will be classified as severe BPD.<sup>2</sup> The infant presented above fits into the category of severe BPD. The management of BPD is teamwork with multidisciplinary approach.<sup>3</sup>

The management includes: mechanical ventilation, oxygen therapy, diet, medications and neurodevelopmental follow-up.<sup>4</sup> As seen the case above, despite of adequate management, was unable to extubate, and the infant ended up on oscillator.

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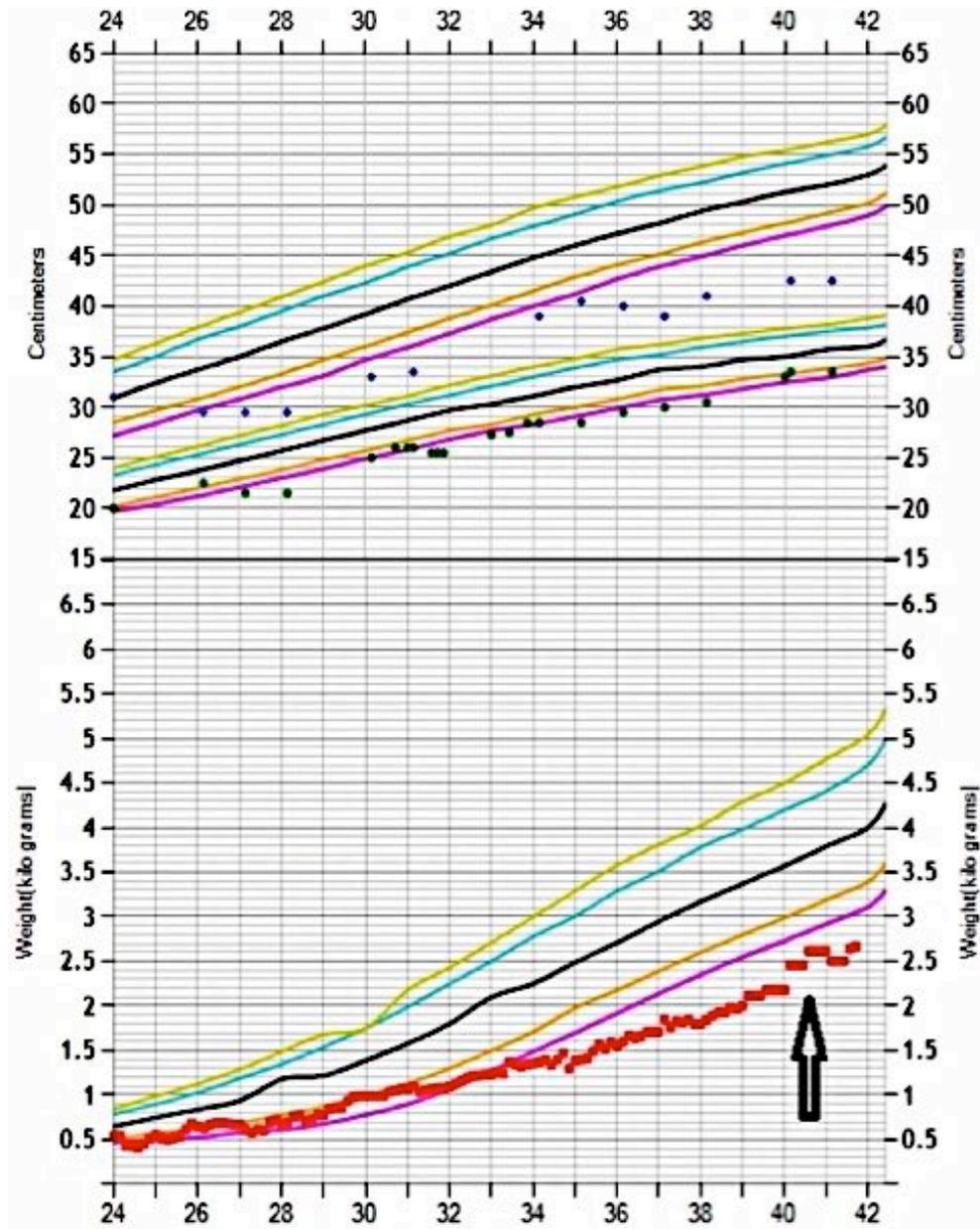


Figure 3. Growth Chart, Black Arrow Depicts the Time of Change in Ventilation.

Pulmonary function in an infant with severe BPD is dominated by increased resistance making the expiration time constant longer.<sup>5</sup> It means that complete exhalation will require longer time. Shepherd et al<sup>1</sup> suggested that by using a low rate and high tidal volume (Vt), we can achieve a reasonable minute ventilation (MV), as MV is the product of rate and tidal volume (MV = Vt x rate). Further, as carbon dioxide (CO<sub>2</sub>) elimination is determined by MV, a change in Vt or rate is reflected as a change in PCO<sub>2</sub> which is a surrogate of adequate ventilation. The infant presented was switched from Oscillator (Fraction Inspired oxygen 100%, Mean Airway Pressure = 24, Amplitude = 60 and Frequency = 5) to Volume-controlled ventilator with the following settings: Fraction Inspired oxygen 100%, Vt of 45 (18 ml/kg), and Rate of 17 per minute. Inspiratory time was set at 0.5 secs, giving an I: E ratio of 1:5, providing long exhalation time for the infant. Within 48 hours of ventilation, the infant was weaned to 55% FiO<sub>2</sub>, PCO<sub>2</sub> improved, and the infant required less sedation. The intervention also resulted in weight gain, see Growth Chart, Figure 3.

This case is an anecdotal experience from a single unit showing short-term benefit. A close follow-up is needed to see the long-term effect of such intervention. The main purpose of this report is to make health care providers aware of the successful use of high Vt, low rate ventilator strategy in infant with severe BPD.

#### References

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