Title : LOW RATE INTERMITTENT MANDATORY VENTILATION (IMV) IN THE NEONATE

Authors : J.G. Shutack, D.O., W.W. Fox, M.D., T.H. Shaffer, Ph.D., J.G. Schwartz, M.S., and A.S. Moomjian, M.D.

Affiliation: University of Pennsylvania School of Medicine, Department of Pediatrics, The Children's Hospital of Philadelphia, and Temple University, Department of Physiology, Philadelphia, Pennsylvania 19104

Introduction. A significant number of low birth weight neonates (<1500 gm) recovering from respiratory distress syndrome (RDS) have unstable lung volumes and are predisposed to atelectasis and apnea. Many of these neonates become dependent on low rate (<10 breaths/min) intermittent mandatory ventilation (IMV). The purpose of this study is to investigate the effects of each IMV breath on pulmonary function (PF) in these infants during weaning from mechanical ventilation on low rate IMV.

Methods. Four intubated low birth weight neonates recovering from RDS were studied in the Infant Intensive Care Unit. Informed parental consent and institutional approval were obtained. Clinical profile of patients (mean ± SEM values): birth wt. 1.5 ± 0.17 kg, gest. age 31 ± 0.91 wks., age when studied 16 ± 7.43 days, $FiO_2$ 0.38 ± 0.05, PEEP 3.75 ± 0.62 cm $H_2O$, IMV 4 ± 0.64 breaths/min., peak inflating pressure 20 ± 0.85 cm $H_2O$, days ventilated when studied 14 ± 6.48, days after study until extubation 6 ± 3.90. PF measurements including dynamic compliance ($C_L$), inspiratory and expiratory resistance ($R_I$ and $R_E$), insp. to exp. time ratio (I:E), and tidal volume ($V_T$) were performed immediately before and immediately after each of 30 IMV breaths. Control functional residual capacity (FRC) was measured with a closed circuit helium technique. A pneumotachograph and esophageal balloon were used to measure flow and pressure. Flow was integrated to volume. No endotracheal tube leakage was present in the four patients as determined by mask and pneumotachograph. Statistical comparison were based on a paired Student's t test.

Results. Mean ± SEM control PF values for all patients pre ventilator breath (VB) were: $C_L$ (ml/cm $H_2O$/kg) 3.21 ± 0.66, $R_I$ (cm $H_2O$/L/sec) 29.39 ± 6.19, $R_E$ 54.93 ± 9.91, I:E0.97 ±0.04, $V_T$ (ml) 6.06 ± 0.30, FRC (ml/kg) 18.7 ± 4.3. Two characteristic respiratory patterns were observed post VB: a) return to new FRC (84%), Fig. 1; b) apnea (16%). Fig. 2 demonstrates that post VB there was a significant increase ($p<0.05$) in mean FRC of 6.8 ml. There were no significant changes in mean $C_L$, $R_I$, $R_E$, or I:E immediately post VB compared to pre VB. As shown in Fig. 3, $V_T$ of the first four consecutive breaths post VB were significantly ($p<0.02$) decreased compared to control breaths pre VB. The $V_T$ progressively returned to control pre IMV breath levels by the fifth breath post VB.

Discussion. This study demonstrates that the effect of each IMV breath is to increase FRC, most likely by opening atelectatic areas of the lung. This same observation of an increase in FRC following a large tidal volume breath has been described in the normal neonate with spontaneous sighs.[1] The decrease in $V_T$ post ventilator breath has also been seen in normal neonates after lung inflation.[2] Studies in adults have reported an increase in $C_L$ after deep breaths however with the degree of pulmonary instability seen in our patients the variability of $C_L$, $R_I$, and $R_E$ is not surprising.[3] This study suggests that in small neonates with unstable lungs each IMV breath increases FRC, thus maintaining a more normal lung volume.

References.

1. Thach BT, Taeusch HW: Sighing in newborn human infants. Role of inflation-augmenting reflex. J Appl Physiol 41:502-507, 1976
2. Cross KW, Klaus M, Tooley WH, Weisser K: The response of the new-born baby to inflation of the lungs. J Physiol (London) 151: 551-565, 1960
3. Egbert LD, Laver MB, Bendixen HH: Intermittent deep breaths and compliance during anesthesia in man. ANESTHESIOLOGY 24:57-60, 1963

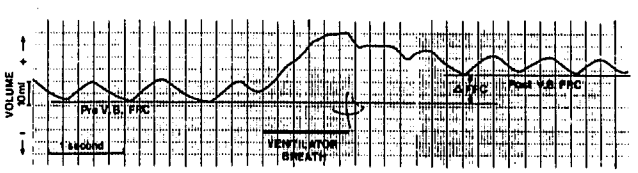


Figure 1

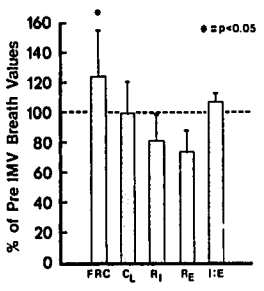


Figure 2

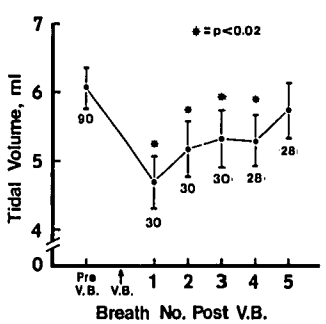


Figure 3