Acta Biomed 2013; 84: Supplement 1: 25-27 



# Efficacy of exogenous surfactant during conventional and high-frequency oscillatory ventilation in preterm infants with RDS

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**Abstract.** *Introduction:* The immediate effects of exogenous surfactant on lung volume and hemodynamics in preterm infants have been poorly studied. *Materials and Methods:* Lung volume, $SpO_2$, perfusion index , regional $SO_2$, transcutaneous partial pressure of $CO_2$ were simultaneously monitored and recorded ten minutes after surfactant tracheal instillation in elective HFOV ventilated preterm infants with RDS. *Outcomes:* Despite a reduction in gas exchange during the first 5 minutes post surfactant instillation, most likely dependent on airway obstruction, lung volume increases rapidly in HFOV preterm infants with RDS. After 5 minutes from administration of surfactant, lung volume, gas exchange and PI reach stable values and CDP can be safely reduced. (www.actabiomedica.it)

**Key words:** surfactant, HFOV, premature neonates

## Introduction

Many preterm infants with respiratory distress syndrome (RDS) need invasive mechanical ventilation and exogenous surfactant administration, despite the increasing use of non-invasive respiratory support (1). Efficacy of exogenous surfactant on lung function was initially studied in animal models, which showed that surfactant increases and stabilizes functional residual capacity (FRC), improves lung compliance, and results in more homogeneous ventilation (2,3). Several studies in preterm infants have explored the effect of exogenous surfactant on lung function in RDS mainly during conventional mechanical ventilation (CMV). These studies showed a positive effect of surfactant on FRC (4). On the contrary, less consistent data were found on the modification of lung compliance, varying from a reduction, to no change, to an increase in compliance after surfactant administration (5-7). The fact that most studies assessed the effect of surfactant on lung function at different points in time after treatment (from 15 minutes to several hours) could explain this inconsistency. A recent study showed that surfactant treatment in preterm infants with RDS receiving high-frequency oscillatory ventilation (HFOV), not only causes a rapid increase and subsequent stabilization of lung volume especially in dependent lung regions, but also increases maximal compliance, this effect being only reached at lower airway pressures (8). In this study rescue surfactant was administered after an open lung ventilation strategy using oxygenation ($FiO_2 \leq 0.25$) as an indirect marker for lung volume (9, 10). The main reason for recruiting the lung before surfactant treatment was to minimize ventilatory induced lung injury (VILI) as much as possible during the pre-surfactant ventilation period. In this way surfactant administration is different from the studies using CMV in which surfactant also plays an important role in lung recruitment (8). The aim of our study was to evaluate the immediate effects of exogenous surfactant on lung

volume and hemodynamics in preterm infants with RDS electively ventilated in HFOV.

## Materials and Methods

Newborns with gestational age (GA) ≤ 27 weeks affected by RDS and receiving elective HFOV were studied during and after surfactant treatment (200 mg/kg of Curosurf®, Chiesi Farmaceutici, Parma, Italy). Changes in lung volume with derived FRC were determined by respiratory inductive plethysmography (RIP) (Bicore-II® device: CareFusion) using two elastic bands (RespiBands™) encircling the ribcage (RC) at the level of the axillae, and the abdomen (Abd) just above the umbilicus. During all-time CDP and calculated FRC (Sum-FRC, RC-FRC and Abd-FRC) changes were digitized, recorded and stored for offline analysis. Continuous and simultaneous absolute values for Perfusion Index (PI), preductal and postductal $SpO_2$, and heart rate (HR) were measured by pulse oximetry (Masimo®). Regional cerebral (cer-$rSO_2$) and peri-renal $rSO_2$ (ren-$rSO_2$) tissue oxygenation were measured by near infrared spectroscopy (NIRS) using INVOS™ 5100C cerebral/somatic oximeter (Covidien, Boulder CO), transcutaneous partial pressure of $CO_2$ ($TcPCO_2$), $DCO_2$ and tidal volume HFOV ($V_T$) were simultaneously recorded.

## Results

Four preterm infants admitted to the III level NICU of Policlinico Gemelli, Università Cattolica S. Cuore in Rome, Italy , with mean ± SD GA of 27 ± 0.1 weeks and mean ± SD birth weight (BW) of 1058 ± 151 grams were studied. Relative FRC increased in all patients after surfactant treatment within 5 min-

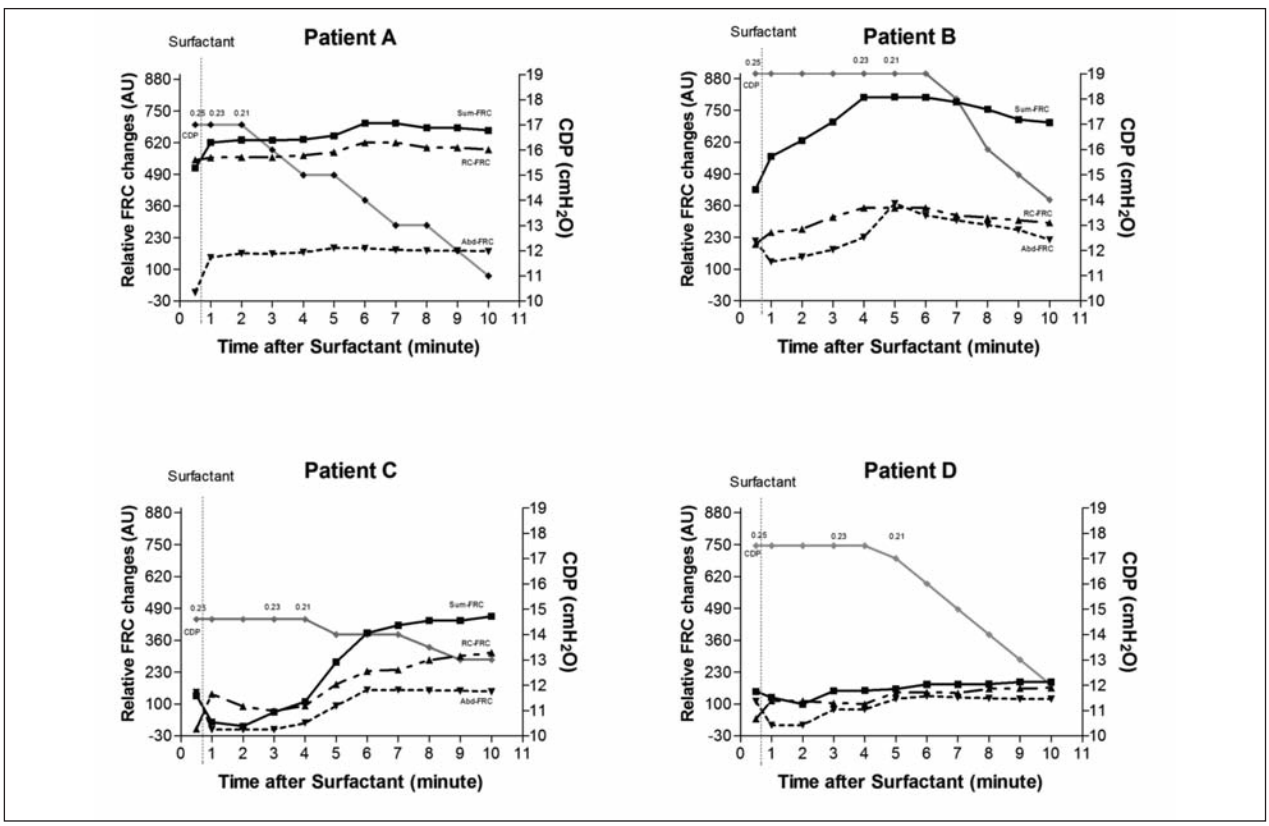


**Figure 1**. Relative FRC increased in all patients within 5 minutes, as well as oxygenation improved from the third minute after surfactant ($FiO_2$ decreased). The higher FRC values remained stable even after CDP reduction occurring within 10 minutes after surfactant instillation

utes with an improvement in oxygenation ($FiO_2$ decreased) (Figure 1). The higher FRC values remained stable even after CDP reduction occurring within 10 minutes after surfactant instillation (Figure 1). Cer- $rSO_2$ and ren- $rSO_2$ values increased within the first 5 minutes post surfactant in all patients, after a temporary reduction in the first minute. PI value increased considerably within 2 minutes after surfactant and then remained stable. $TcPCO_2$ increased in the first minute post surfactant, then decreased within the first 5 minutes and remained stable. On the contrary, $DCO_2$ and $V_T$ values increased within the first 5 minutes, after a significant decrease in the first minute post surfactant. The higher FRC, PI, $SpO_2$, cer- $rSO_2$ and ren- $rSO_2$ values and the stable $TcPCO_2$, $DCO_2$ and $V_T$ values, reached within the first 5 minutes after surfactant treatment, remained stable even after the gradual reduction of CDP value, within 10 minutes after surfactant instillation.

## Discussion

Despite a reduction in gas exchange during the first 5 minutes post surfactant instillation, most likely dependent on airway obstruction, lung volume increases rapidly in HFOV preterm infants with RDS. Surfactant instillation determines an increase of PI value, dependent on a reduction in pulmonary vascular resistance, which in turn causes an increase of pulmonary blood flow and left ventricular output. After 5 minutes from administration of surfactant, lung volume, gas exchange and PI reach stable values and CDP can be safely reduced. All the patients in this study were treated with open lung HFOV. The results may be different during conventional (tidal) ventilation, during which surfactant also plays an important role in lung recruitment.

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