

Lung recruitment strategy and surfactant in delivery room

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Abstract. The aim of neonatal resuscitation is to establish an effective ventilation, avoiding lung damage. PEEP and T-piece use, as well as Sustained Lung Inflation, lower O₂ target and appropriately timed surfactant administration analyzed. A new “gentle” respiratory approach in delivery room can improve newborn respiratory outcome. (www.actabiomedica.it)

Key words: lung recruitment, sustained lung inflation, surfactant, delivery room, preterm infants

Introduction

Correct treatment of depressed newborn in the delivery room has enormous clinical and prognostic importance in both immediate resuscitation and long term outcome.

Resuscitation management in the delivery room is never an easy task and it is compounded by the lack of sufficient and established scientific evidence.

The aim of initial resuscitation of preterm and apneic term infants is to establish an effective ventilation to achieve functional residual capacity (FRC) and facilitate initiation of gas exchange, but many delivery room procedures have secondary effects capable of causing permanent lung damage.

Recently increasing attention has been paid to providing lung protection starting with the first breath; moreover several strategies have been experimented to mitigate lung injury such as lower oxygen concentrations, early use of continuous positive airway pressure (CPAP) and PEEP, pressure and volume optimization during ventilation, sustained inflations, less frequent use of prophylactic intubation and mechanical ventilation (MV), need for and timing of surfactant therapy, correct management of meconium-stained amniotic fluid (1).

In this paper we consider some aspects of neonatal resuscitation and in particular the most promising lung recruitment strategies, such as PEEP, early use of CPAP, sustained lung inflation (SLI) and administration of artificial surfactant.

PEEP and early CPAP

In recent times, in order to avoid lung collapse at the end of expiration, several Authors (2, 3) have emphasized the role of PEEP starting with the very first breath, and the early and prophylactic use of nCPAP already in the delivery room.

Lungs of preterm infants at birth are surfactant deficient, and so it may be difficult to achieve optimal FRC and maintain open alveoli during expiratory periods.

Current International Liaison Committee on Resuscitation (ILCOR) and American Academy of Pediatrics (AAP)/American Heart Association (AHA) recommendations affirm that ventilation of the newborn can be performed effectively with a flow-inflating bag (FIB), a self-inflating bag (SIB), or a pressure-limited T-piece resuscitator (4).

All these devices have advantages and disadvantages: SIB is unable to provide CPAP and oxygen reli-

ably, but is easier to use and more popular. FIB can deliver up to 100% oxygen and is very commonly used by anesthesiologists, but it involves several risks because of high pressure; T-piece resuscitator delivers desired ventilation pressure more accurately, but often requires a longer time to set up and it is technically more difficult.

Studies on mannequins showed a greater effectiveness of the T-piece which provides more reliable pressure values (4). Although no significant differences between the use of the T-piece and SIB in vivo (5, 6) Szyld et al. (7) in a multicenter cluster randomized 2-period crossover trial on a premature infants born >26 week's gestation, found no significant differences in the number of newborns with heart rate >100 per 2 minutes (primary outcome), but they observed that the use of the T-piece was associated with a reduction in intubation (17% vs 26% OR 0.58; 95% CI, 0.4-0.8; $p = 0.002$) and applied peak pressure (maximum pressures applied (26 ± 2 vs 28 ± 2 cm H₂O; $p < 0.001$) compared to SIB.

Sustained Lung Inflation (SLI)

Recently, several authors have proposed a new approach to lung recruitment (Sustained Lung Inflation - SLI), which seems to show good results when associated with PEEP. It consists in proceeding positive insufflation pressure (20-25 cm H₂O) for 15-20" followed by standard with PEEP ventilation after initial aspiration of the upper airways.

In fact, continuous "opening and closing" of the alveoli is not an optimal recruitment strategy because it may cause over-distension of some lung areas and collapse of others, with severe pulmonary dishomogeneity.

In a RCT, Lindner et al. (8) found that giving preterm infants an initial SLI (20-25 cm H₂O) for 15-20 s did not reduce the rate of intubation and MV in comparison with regular nasal intermittent mandatory ventilation, despite a lower intubation rate in the DR group.

Te Pas and Walther (9) compared in a group of preterm infants compared SLI (20 cm H₂O for 10 s) with SIB and mask ventilation, demonstrating a decrease in the need for intubation and MV within the

first 72 hours of life (37% vs 51%; $p = 0.04$) and BPD (22% vs 34%; $p = 0.5$) in the first cohort.

Similar results were reported by Lista et al (10), where SLI + CPAP were proven effective in reducing the need for VM and the rate of BPD in survivors compared to a control group treated only with CPAP.

Polglase et al (11) in an animal model, assuming that lung injury is mainly due to volutrauma, compared two different SLI strategies: traditional pressure-limited SLI and volume-limited SLI. Except for lower oxygenation, volume-limited SLI did not provide different results compared as opposed to pressure-limited SLI.

Currently, a systematic review that definitively establishes the effectiveness of SLI associated with CPAP has not been unequivocally demonstrated, but this strategy appears to be an intriguing method of opening lungs and achieving initial FRC. Therefore several Authors have supported its use, but the final decision regarding the optimal recruitment strategy should take into account local expertise and preferences.

Surfactant in delivery room

In the last decades, surfactant has played a key role in the management of RDS of the preterm infant. Its use in neonatology has improved survival and outcome of premature infants, reducing mortality, development of BPD and duration of MV. Since its introduction, the dogma has been the earlier the administration in preterm infants, the better their outcome (12).

Therefore initially prophylactic administration in premature infants with EG of less than 29-30 weeks was proposed. This strategy has the advantage of replacing surfactant before the manifestation of clinical signs of RDS and therefore significantly reduces the risk of VILI (13). Unfortunately the prophylaxis involves invasive procedures such as intubation and MV, and exposes newborns, even those who would not develop RDS, to the consequent risks.

The "rescue" strategy (administration reserved to infants with RDS), avoids exposing these infants to such risks and is preferred by most neonatologists. In fact, thanks to increased prenatal steroid prophylaxis

and early deliver-room application of PEEP, many infants, including ELBW, are able to breathe independently without the need for intubation and MV.

Several clinical trials (14-16) have shown that this strategy, characterized by an early use of CPAP starting immediately in the delivery room, and a more selective surfactant administration, is equally effective in reducing the duration of mechanical ventilation and major morbidities related to prematurity. Recently, Vanpée M et al (17) have compared the use of early CPAP compared to intubation and elective MV in a group of premature infants with EG <28 weeks and have demonstrated that early CPAP leads to a reduction in the need for intubation, lower MAP and also a reduced need for oxygen at 40 weeks of EPC.

Recently, a meta-analysis by the Cochrane Collaboration has confirmed the lower risk of CLD and death associated with the adoption of this strategy (18).

While establishing the greater effectiveness of a “rescue” strategy with respect to prophylactic administration, it should be emphasised, however, that early administration of surfactant (within the first 2 hours of life) compared to delayed administration (> 2 hours), provides a better survival and a better respiratory outcome both in the short and in long term (19, 20).

Nevertheless, surfactant are more effective, the sooner the lungs are recruited, because its distribution in these conditions is more homogeneous. For this reason, many authors have suggested different strategies to achieve alveolar recruitment as early as possible.

In several studies, the application of PEEP or better PEEP + VT before and during administration of surfactant seems to determine a significant improvement in lung capacity (21) Frerichs has instead advocated the importance of a recruitment maneuver after instillation of surfactant (22).

In recent years a new method of surfactant administration by thin catheter in the pharynx during nCPAP has been proposed. This procedure would seem effective in reducing the duration of both non-invasive and invasive ventilation, oxygen dependence and incidence of BPD. This represents a viable alternative to INSURE, and a good strategy to enhance the effects of the alveolar recruitment and gentle ventilation (23).

Conclusions

As recently shown also by the European Consensus surfactant (24), should be administered as early as possible after the onset of respiratory distress, using reduced FiO₂ thresholds and always after an adequate lung recruitment manoeuvre. The latter should be initiated in the delivery room with the use of SLI and subsequent ventilation with PEEP, and continue in the NICU.

The decision to administer surfactant in the delivery room or NICU thus reflects more organizational issues than clinical uncertainties. Only in severely preterm infants (with gestation age <24-26 weeks) and in the presence of additional risk factors (e.g. ineffective steroid prophylaxis) is a prophylactic use of surfactant conceivable today, but also in this case, if possible, it is best if preceded by an adequate alveolar recruitment administration.

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