Nasal CPAP and/or Surfactant for Immediate Use in Tiny Preterm Infants

By Roger E. Sheldon, MD MPH

Abstract: Early CPAP, early pulmonary surfactant replacement, followed by nasal CPAP seems to provide for better stabilization of the newborn preemie, allowing for less mechanical ventilation, shorter periods of intubation and oxygen therapy, and presumably less chronic lung disease.

Tiny premature infants are often able to avoid mechanical ventilation these days by early treatment with continuous distending pressure with or without pulmonary surfactant. Evidence is accumulating that nasal continuous positive airway pressure (NCPAP), administered very early after birth, can bridge the child through the transition to air-breathing, can recruit and maintain a uniformly aerated lung, and with or without surfactant, can support the child without long term intubation and ventilation. This can be expected to reduce the incidence of chronic lung disease (bronchopulmonary dysplasia).

Over the years, we have taught and advised pediatricians and family doctors at basic (Level I) hospitals to forego the use of surfactant (until after transport to the neonatal center). This reflected a fear that surfactant would produce an unstable situation with the child's ventilation (labile ventilator settings, airway obstruction by surfactant and secretions, or pneumothorax) and would make transportation more dangerous. Now it appears that early surfactant provides enough advantage that it should not be delayed in those children who need it. Care and judicious use of blood gas measurements before transport may allow us to reduce the dangers of transport most of the time.

WHICH CHILDREN NEED EARLY NCPAP?
Continuous distending pressure is a treatment for the tendency of the lung to collapse when pulmonary surfactant is lacking—the classic premature respiratory distress syndrome (RDS) or hyaline membrane disease (HMD). Prematures may be assumed to need this sort of treatment when born before 33-34 weeks, especially before 30 weeks, when they have immature lung testing, or when they lack complete prenatal maternal steroid treatment. Additional children may be diagnosed later with RDS by clinical findings or x-ray.

WHICH CHILDREN NEED EARLY SURFACTANT?
Exogenous pulmonary surfactant repairs the surfactant deficiency in these same surfactant-deficient premature infants. Since it is quite expensive, most centers are using it presumptively only on preemies born under 30 weeks and 1250 grams or even smaller. This has been termed prophylactic treatment. Later diagnosis can justify treatment in older or larger babies once they have been shown to actually have the disease. This has been termed rescue treatment.

Surfactant administration requires atraumatic endotracheal intubation, specialized equipment for insertion, and excellent supportive care (oxygenation, thermal control, fluid and glucose support). Therefore, surfactant must be administered by a physician skilled in endotracheal intubation of the premature infant and capable of providing the supportive care necessary after administration.
HOW EARLY IS EARLY? The application of continuous distending pressure from the moment of birth appears to assist the child in opening the alveoli, recruiting the appropriate functional residual capacity of air within the alveoli, and preventing these air spaces from emptying at the end of expiration when surfactant is not sufficient to prevent the emptying. This is especially important in the presence of poor inspiratory effort or positive pressure ventilation at birth. Conventional "ambu" bags do not provide uniform inspiratory pressures or CPAP; we have had good results with a device that administers both uniform breaths and steady CPAP by either mask or endotracheal tube (NeoPuff, Fisher-Paykel Healthcare; www.fphcare.com/neonatal/).

While immediate application of CPAP is fairly easy to achieve, delivery room administration of surfactant requires endotracheal intubation and takes some time. If the child requires intubation for resuscitation, one may take the opportunity to administer surfactant right away. Otherwise, intubation and administration in the nursery, a few minutes later, probably has similar effectiveness, and allows for better thermal management and stabilization.

A recent paper from Denmark and Sweden¹ showed that NCPAP alone stabilized ½ of 60 babies born at less than 30 weeks, thus preventing the need for either surfactant or ventilation. Another 25% were managed by adding surfactant to the NCPAP. Thus, ¾ of all preemies in this small group, including many weighing less than a kilogram, needed no mechanical ventilation at all.

WHAT ABOUT AFTER THE SURFACTANT? Once the surfactant is given, caregivers must be attentive to aggressive reductions in inspiratory pressure (if the child is being ventilated) and FIO₂. Inspiratory pressures can be reduced by 10-25% immediately upon the administration of the surfactant. Oxygen should be reduced rapidly to the lowest level consistent with normal oxygen saturations/PO2s. In any case, saturations around 100% are bad, not good, for these children. The target saturation should be between 90 and 97% and the PO2 between 50 and 70 mmHg. This rapidly changing therapy prompts us to obtain blood gas measurements before transporting the child.

WHAT ABOUT COMPLICATIONS? If the ventilator settings are managed promptly, complications will be relatively infrequent. Prompt reductions in pressures will lead to even lower incidence of pneumothorax than without surfactant. Plugging is the main remaining complication to watch for. If there are secretions, tracheal suctioning should be done before the surfactant is given. Ideally, no suctioning will be done in the hour or two after the surfactant, in order not to remove part of the medication itself. However, tracheal or bronchial plugging by surfactant or by mobilized tracheal secretions will occasionally require suction and clearing of the airway.

WHEN DO WE EXTUBATE THE CHILD? Ideally, the child with good inspiratory effort can be extubated shortly after the surfactant administration. A recent paper from Italy² indicated that extubation immediately after surfactant led to little later ventilation and shorter times on oxygen, CPAP, ventilation and time in the NICU.

HOW DO WE DO NASAL CPAP? Nasal CPAP, either by the bubble method³ or by using a nasal connector to a ventilator or other pressure generator, requires attentive application of the device and close continuous attention by the nursing staff. NCPAP actually requires more attention than does a child on a ventilator–approaching 1-to-1 nursing ratio and staffing. This relates to the insecurity of the connection between the device and the child's nose, and his tendency to open his mouth, thus releasing the pressure and breathing air from the room. Injury to the child's skin and nasal septum is frequent and dried secretions are a problem often requiring nasal suction and saline rinses. The details are beyond this article⁴, but please do not assume that this is a simple treatment. All basic nurseries and many intermediate nurseries should refer these tiny babies (or their mothers before delivery) to the perinatal center for this difficult treatment. If you choose to offer NCPAP, you should send people from your nursery to a center using NCPAP for training.

SUMMARY: Early CPAP, early pulmonary surfactant replacement, followed by nasal CPAP seems to provide for better stabilization of the newborn preemie, allowing for less mechanical ventilation, shorter periods of intubation and oxygen therapy, and presumably less chronic lung disease.⁴,⁵ These treatments are expensive and demanding.

AWHONN Fetal Heart Monitoring Principles and Practices Instructor Course

The Office of Perinatal Continuing Education will be offering an Instructor Enhancement Course in the fall of 2005 for those interested in becoming an instructor for the Association of Women's Health, Obstetric and Neonatal Nurses’ (AWHONN) Fetal Heart Monitoring Principles and Practices (FHMPP) program. Requirements for instructors are as follows: You must have a minimum of two years experience in intrapartum care; have current clinical involvement in fetal heart monitoring as a staff nurse, manager, clinical nurse specialist, or educator that includes responsibilities for evaluation of clinical skills of others in fetal heart monitoring; and, maintain your own professional development in intrapartum care and fetal heart monitoring through attendance at relevant continuing education activities. You must also have successfully completed the two-day FHMPP workshop and become a member of AWHONN, if not currently a member. The course will be offered at the OU Health Sciences Center in Oklahoma City in the Rogers Building. It will be taught by Barbara O'Brien. Please contact her if interested at (405) 271-7777. Enrollment is limited to eight participants.

EFM Strip Teaser –
With Warren Crosby, M.D., Perinatologist, Program Director-Office of Perinatal Continuing Education

A 24 y/o woman, G2, P1001 presents to L&D at 39 weeks complaining of decreased fetal movement and some contractions. She was delivered by C-section with her first pregnancy for failure to progress (FTP). She desires a Vaginal Birth After Cesarean (VBAC) for this pregnancy. Her physician had performed pelvimetry, which was normal. Her contractions palpated strong upon admission and the nurse questioned whether there was uterine relaxation between contractions. This was relayed to the woman's physician. Her cervical exam was 2 cm dilated, 100% effaced, and 0 station. This is her tracing soon after admission:

Strip A

Approximately one hour after admission the woman went to the toilet. While the woman was in the restroom, she called to her nurse complaining of "a gush of bloody fluid in the toilet". The nurse immediately assisted the patient back to her bed. The patient complained of increasing pain and requested a C-section. This is her tracing upon her return to bed:

Strip B

Interpret both tracings with the following information:

Describe the uterine activity.
Describe the fetal response.
Is this reassuring or nonreassuring?
What are your actions?
What are the most likely causes of these findings?

Continued on p.4
**EFM Strip Teaser—Comments**

In the initial tracing, there are contractions approximately every 1 ½ to 2 minutes, lasting 50-80 seconds, strong to palpation, and firm between contractions. The FHR baseline is 147-152 bpm with minimal variability; absent accelerations and decelerations. The tracing is nonreassuring due to the excessive uterine activity, minimal variability and absent accelerations. The nurse notified the physician of these findings but did let the woman go to the restroom. When the tracing is nonreassuring, further continuous monitoring may be prudent.

The second tracing shows elevated resting tonus; other findings of uterine activity are difficult to interpret. Palpation and adjustment of the TOCO are indicated. The FHR baseline is approximately 155 bpm with absent variability; no accelerations or decelerations. This tracing is nonreassuring, most notably with the elevated resting tonus and absent variability. Adding the vaginal bleeding to this clinical picture increases the significance of these findings. The nurse immediately notified the physician and proceeded with intraruterine resuscitation procedures (lateral maternal position, fluid bolus, and O2). Since the woman is attempting a VBAC, abdominal pain and vaginal bleeding could indicate a uterine rupture. The elevated uterine tonus, abdominal pain and vaginal bleeding could also indicate a placental abruption. The plan of action for either one would be an immediate C-section.

**Outcome:** The patient was delivered by C-section. Upon entering the uterus, a 50% placental abruption was found. The male infant weighed 2390 grams with Apgars of 1/1. A full resuscitation was immediately done, and he responded fairly quickly, although a 10-minute Apgar score was not obtained. The umbilical cord pHs were 7.19 (venous) and 7.16 (arterial). Both mother and baby were discharged on Day 4.

**Discussion:** The abruption must have occurred when the membranes ruptured (or the other way around). The presence of blood in the fluid can be evidence of placental separation. This was the most likely case here because of the elevated uterine tonus, abdominal pain, and vaginal bleeding. The fetal response was decreased variability. The absence of decelerations is unusual, but some may have occurred when she was off the monitor in the restroom.

In spite of the dramatic changes in these tracings and the low Apgar scores, the umbilical cord gases did not show metabolic acidosis; this may be why the baby responded so well to the resuscitation.