Update on neonatal resuscitation

Schure AY, MD, DEAA
Assistant Professor in Cardiac Anesthesia & Clinical Instructor Harvard Medical School, Department of Anesthesiology, Critical Care and Pain Medicine, Children's Hospital, Boston, Massachusetts
Correspondence to: Prof A Schure, e-mail: ayschure@yahoo.de

Introduction

In these times of highly subspecialised medicine, many anaesthesiologists in the US think of neonatal resuscitation as the sole responsibility of neonatologists and paediatricians. But does this role assignment really release anaesthesiologists from the obligation to know how to perform an effective resuscitation of a newborn in the delivery room?

The majority of babies are still born in small hospitals with limited staff and resources. A paediatrician or neonatologist might not always be available. A recent survey in the US, conducted among third year paediatric residents, showed a surprising deficiency in neonatal intubation skills.[1] Around 10% of all newborns require some assistance after birth, and 1% will need full resuscitation. For preterm or low birth weight infants, this percentage increases dramatically. Unfortunately, only 60% of resuscitations are predictable antepartum, and often a timely maternal transfer to a tertiary centre is not possible.[2]

Therefore, it is important that everyone who is involved in delivery room care, including the anaesthesiologist, frequently reviews the principles of neonatal resuscitation, checks and maintains the necessary equipment, and organises contingency plans for additional help.

The physiology of transition

A detailed discussion of the neonatal adaptation to extra-uterine life is far beyond the scope of this review. The following is a short summery of major key points.

The respiratory adaptation consists of a decrease in pulmonary vascular resistance and increase in pulmonary blood flow stimulated by lung expansion, increased oxygen tension and release of nitric oxide with the onset of spontaneous breathing. The cardiovascular changes are dominated by the loss of the low resistance placenta and a subsequent increase in the systemic vascular resistance, followed by closure of the foetal shunts (ductus arteriosus, patent foramen, ductus venosus) with shifting resistance ratios, increased oxygen tension and falling prostaglandin levels.[3]

Risk assessment

Table I: Antepartum factors associated with the need for resuscitation

• Maternal diabetes mellitus	• Premature rupture of membranes
• Pregnancy induced hypertension	• Foetal hydrops
• Chronic hypertension	• Post-term gestation
• Foetal anaemia	• Multiple gestation
• Previous foetal death	• Size-dates discrepancy
• 2nd or 3rd trimester bleeding	• Drug therapy (e.g. magnesium)
• Maternal infection	• Maternal substance abuse
• Significant maternal disease	• Foetal malformation
• Polyhydramnios	• Diminished foetal activity
• Oligohydramnios	• Inadequate prenatal care
	• Age < 16 or > 35 years

Table II: Intrapartum factors associated with the need for resuscitation

• Emergency C-Section	• Persistent foetal bradycardia
• Forceps or vacuum delivery	• Non-reassuring foetal heart rate pattern
• Breech	• General anaesthesia
• Premature labour	• Uterine hyperstimulation
• Precipitous labour	• Narcotics within last 4 hours
• Chorioamnionitis	• Meconium stained fluid
• Prolonged rupture of membranes > 18 hours	• Prolapsed cord
• Prolonged labour > 24 hours	• Abruptio placenta
• Prolonged second stage > 2 hours	• Placenta previa
• Macrosomia	• Significant bleeding

Preparation for resuscitation

Every resuscitation starts with the appropriate preparation. It implies the availability and maintenance of necessary, size-appropriate equipment, as well as the education and training of staff and auxiliary personnel. In addition, resource management and transfer arrangements for high-risk deliveries should be part of the planning.

The basic equipment consists of radiant warmer, warm blankets, source of oxygen, airway equipment, source of regulated suction,

equipment for intravenous access, intravenous fluids, sets for umbilical vessel catheterisation and drugs for resuscitation.

Step-by-step approach to neonatal resuscitation

Step 1: Initial assessment: A is for Airway

During the first 30 seconds, a quick initial assessment is done and routine care provided. Is this a term baby? Was the amniotic fluid clear? Is the baby breathing or crying? How is the muscle tone?

The baby is placed under the radiant warmer, the airway is cleared by positioning or suction as necessary (mouth before nose), warm towels are used to thoroughly dry the baby and, finally, the colour is assessed. If the baby is not breathing, he or she should be gently stimulated by flicking the soles or rubbing the back and then repositioned.

Step 2: Evaluation: B is for Breathing

After 30 seconds of initial assessment and routine care, respirations, heart rate and colour are evaluated. If the baby is breathing, looks pink and the heart rate is > 100 bpm, no further intervention is necessary. In case of a cyanotic, but breathing, baby with an adequate heart rate, supplemental oxygen is provided and the baby is re-evaluated. For apnoeic babies or if the heart rate is < 100 bpm, positive pressure ventilation is started with initial inflating pressures up to 30 -40 cmH_2O and ventilatory rates of 40 - 60 breaths per minute.

Step 3: Evaluation: C is for Circulation and D is for Drugs

After 30 seconds of effective ventilation, the baby is re-evaluated. If the newborn is pink and the heart rate > 100 bpm, routine post resuscitation care is indicated. On the other hand, if the heart rate is < 60 bpm, positive pressure ventilation should be continued and chest compressions started. The "thumb" or "2 finger" technique can be used, as long as the rate is around 90 bpm, the compression depth must be 1/3 of the anterior-posterior chest diameter and the compression-ventilation ration 3:1, allowing for 120 events per minute.

If the heart rate is still < 60 bpm after 60 seconds of effective ventilation and 30 seconds of chest compressions, epinephrine is indicated (1:10 000 dilution). The preferred route of administration is intravenously via the umbilical vein. The dose is 10 – 30 µg/kg and may be repeated every 3 – 5 minutes. As an alternative, epinephrine can be given via the endotracheal tube, but higher doses (30 – 100 µg/kg) are recommended due to the unreliable absorption and efficacy.

Endotracheal intubation may be indicated at several time points during the resuscitation: for tracheal suctioning of thick meconium in non-vigorous newborns, when bag-mask ventilation is ineffective (extreme low birth weight, congenital anomalies, etc), during chest compressions or for endotracheal administration of medications. The position should always be confirmed with exhaled CO_2 detection, and the tube secured safely.

Occasionally other medications are required during the resuscitation. When the baby is pale with weak pulses and there is evidence of foetal blood loss (e.g. placenta praevia), volume expansion with normal saline, Ringer's lactate or O Rh-negative packed red blood cells, 10 ml/kg over 5 - 10 minutes via the umbilical vein, can help restore adequate circulation.

Sodium bicarbonate and naloxone are no longer recommended for routine neonatal resuscitations. Sodium bicarbonate should only be given after adequate ventilation has been established, in the later stage of prolonged resuscitation efforts, and is best guided by blood gas analysis. Naloxone is only indicated in continued respiratory depression with good heart rate and colour and a history of maternal narcotic administration within 4 hours of delivery.

Immediate post-resuscitation period

After the initial resuscitation, the attention should focus on maintenance of airway and ventilation, management of fluids and electrolytes, and preparation for transport. Careful mechanical ventilation with warm, humidified O_2 and adequate and safe settings (there is a risk of over distension) is initiated. The FiO_2 must be adjusted to maintain O_2 saturations for term babies between 90 - 96%, and preterm babies 88 - 92%. Blood glucose levels are checked; if necessary (< 40 – 45 mg/dl), a dextrose infusion ($D_{10}W$) at 3 ml/kg/h is initiated. Prior to transport, all lines and tubes have to be secured and documentation completed.

Extreme prematurity

Resuscitation for extremely premature babies carries additional risks and requires special equipment and trained personnel. These babies are prone to excessive heat loss, very vulnerable to hyperoxic injury and have immature organ systems that are easily permanently damaged. Special intubation skills, strategies for temperature control, oxygen blenders and pulse oximetry are essential for success.[2]

Recent changes and current controversies

Room air or 100% oxygen ?

For many years, routine administration of 100% oxygen during neonatal resuscitation has been used to prevent severe hypoxia. Lately, the focus has shifted on the risks associated with hyperoxia, especially in preterm infants with reduced levels of antioxidant enzymes; hyperoxia promotes the generation of free oxygen radicals, which cause cellular and tissue damage.

Meta-analysis of controlled studies suggests a better outcome for neonates resuscitated with room air instead of 100% oxygen.[4-6] Unfortunately methodological limitations, poor design of some of the included studies and focus on primarily full term non-risk newborns make the interpretation of the data difficult. Ideally, pulse oximetry

should be used to guide oxygen therapy, but there are no well established reference values for the first minutes of life.

Until further data are available, the American Heart Association (AHA) and American Academy of Pediatrics (AAP) still recommend the use of supplemental oxygen when positive pressure ventilation is initiated, and free-flowing oxygen for central cyanosis. Individual clinicians may start resuscitation with room air or supplemental O_2. If room air is used, supplemental oxygen must be readily available and should be added if the newborn fails to improve. If supplemental O_2 is used in the beginning, it should be withdrawn as soon as the infant is pink or the saturation reaches 92%.[2,7]

Timing of surfactant

Recent studies have indicated better outcomes with early prophylactic dosing of surfactant, before the first breath or within the first minutes. The fluid filled lungs allow for better distribution, but the administration can interrupt or delay the resuscitation efforts and is not always necessary.

Current suggestions include the prenatal identification of surfactant deficiency and, for infants < 30 weeks gestational age (GA), the administration of surfactant within the first few minutes of birth. More mature babies (> 30 weeks GA) can receive surfactant as a rescue therapy if respiratory distress syndrome (RDS) develops.[8]

Clearing the airway of meconium

In contrast to the traditional teaching of extensive intra- and postpartum suctioning for all babies born with meconium-stained amniotic fluid, recent studies have shown no difference if other approaches are used.[9-11] Currently, routine intrapartum suctioning is no longer recommended. Vigorous infants, characterised by strong respiratory efforts, good muscle tone and heart rates > 100 bpm, do not require intubation and suctioning. On the other hand, depressed infants still benefit from these manoeuvres before initiation of positive pressure ventilation.[2]

Induced hypothermia

In 2005, several multi-centre trials were published, looking at the benefit of selective head cooling (34 - 35°C and mild systemic hypothermia) and whole body hypothermia (33,5°) after neonatal resuscitation. Despite some promising outcomes in subgroups, the data are currently insufficient to recommend routine use, but emphasise the importance of avoiding hyperthermia.[12,13]

Withholding and discontinuation of resuscitation

The decision to withhold resuscitation efforts should be made by the obstetrical and neonatal team as well as the parents, and is always dependent on regional morbidity/mortality data and available resources. Withholding resuscitation can be considered for babies where the gestational age, birth weight or congenital anomalies are associated with almost certain death (GA < 23 weeks, birth weight < 400 g, trisomy 13 or 18, etc). Sometimes parents wish to withhold resuscitation, especially in situations with uncertain prognosis, borderline survival rate and high morbidity rates.

According to current guidelines the resuscitation may be discontinued if, after 10 minutes of continuous and adequate efforts, no signs of life are present. Survival is highly unlikely after this time.[2]

A complete list of references is available from the author