

# Care and Resuscitation of the Newborn Infant

## Revised Recommendations of the Swiss Society of Neonatology (2007)

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### Introduction

#### Development and Application of these Recommendations

Over the past several years various national and international medical societies have developed recommendations on neonatal resuscitation<sup>1-4</sup>. Based on these publications, a working group within the Swiss Society of Neonatology (SGN) worked out recommendations pertaining to neonatal resuscitation for Switzerland in 2000, and very recently updated them on the basis of emerging new data and revisions of international recommendations<sup>5,6</sup>. These revised recommendations should be considered as guidelines to be adapted as the individual situation requires.

#### Aim and Target Audience of these Recommendations

These recommendations apply to the care of newborn infants older than 34 weeks gestational age and with a birth weight >2000 g. They are valid in the delivery room as well as for the entire neonatal period. They are addressed to all obstetrical clinics in Switzerland as well as to all paediatricians, neonatologists, obstetricians, anaesthetists, midwives, and neonatal nurses.

### Organisation

#### General Aspects

Up to 10% of all newborn infants require simple respiratory support within the first minutes of life. More complex resuscitation measures are needed in only about 1% of newborn infants<sup>5,7</sup>. Trained personnel and specific technical equipment must be readily available at every delivery because risk situations cannot always be predicted.

#### Requirements for Optimal Care of the Newborn Infant:

- **Communication** between midwives, obstetricians and paediatricians (neonatologists).
- Sufficient **information** about the risks for the newborn infant, available already before delivery.
- **Anticipation** of problems which may arise.
- Careful **planning** and preparation of equipment and of the personnel.
- Clear and calm **leading of the resuscitation** by a competent professional who is trained in neonatal resuscitation.

#### Personnel

Ideally, one person is solely in charge of caring for the newborn infant. This person should be able to initiate a resuscitation, i.e. free the airways and use a bag-and-mask ventilation. For further measures, especially for endotracheal intubation, help from an experienced professional in neonatal resuscitation (neonatologist, paediatrician, anaesthetist) must be requested.

Even after a risk-free delivery the newborn infant can present with unforeseen problems. This is why every obstetrical clinic/labour ward must provide a well-equipped, functioning resuscitation table (*see list 1*), and a readily available person experienced in neonatal resuscitation. The obstetrician is primarily responsible for the newborn infant in the delivery room; in individual cases, he may delegate the responsibility to a colleague of a different specialty, preferably to a paediatrician or neonatologist.

#### Equipment

A checklist with the required equipment for a hospital or home delivery is given in the appendix (*list 1 and 2*).

#### Prenatal Transfer of High-Risk Pregnant Women

Delivery of certain high-risk pregnant women requires specialised knowledge, capabilities, and equipment in view of optimal care of the mother and her infant. These requirements are not available in all maternity clinics due to low incidence, reasons of experience, and costs.

Based on this, a small number of pregnant women need to be transferred to a perinatal centre with a neonatal intensive care unit before a planned or impending delivery.

#### Indications for Prenatal Transfer

Intrauterine transport to a perinatal centre is indicated in all cases where the newborn infant might require resuscitation or intensive care.

##### A) Absolute indications include:

- Impending delivery before 32 weeks of gestation.
- Anticipated difficulties in adaptation where intensive care might be required.
- Multiple pregnancy ( $\geq$  triplets).
- Prenatally diagnosed anomalies, requiring immediate postnatal interventions.

##### B) Relative indications include: (when in doubt, and depending on local circumstances, the closest perinatal centre should be consulted)

- Impending delivery up to 35 weeks of gestation.
- Estimated birth weight below 2000 g.
- Intrauterine infection.
- Haemolytic disease of the fetus.
- Fetal arrhythmia.
- Intrauterine growth retardation (<5<sup>th</sup> percentile).
- Chronic or unstable illness of the mother (e.g. hypertension, pre-eclampsia, HELLP-syndrome, diabetes mellitus, status post organ transplant, autoimmune diseases).
- Maternal substance abuse.
- A fetus with a lethal malformation where intensive care is not considered meaningful.

### Neonatal Adaptation

#### Introduction

Transition from intra- to extra-uterine life requires a number of biological adaptive steps that are especially important for the integral functioning of

the central nervous system. The delivery and the first days of life however are also an emotional event that profoundly influences the future parent-infant relationship. Perinatal care must take into consideration these adaptive and emotional processes, and weigh them accordingly.

**Preparation for Delivery Room Management**

- Preheat delivery room (ideally to 25°C).
- Switch on radiant warmer and light.
- Read mother’s chart and evaluate if additional experienced personnel might be required.
- Check equipment.
- Wash hands and wear non-sterile gloves.
- Start Apgar-Timer or stop watch after complete delivery of the infant.

**Cord Clamping**

Infants at risk of hypovolaemia (especially after vacuum extraction or delivery out of breech presentation) can be positioned 20–30 cm below vaginal introitus, and the cord clamped 45–60 seconds post delivery, thus enabling a placentoneonatal transfusion<sup>8)–10), a)</sup>.

**Clinical Assessment of Adaptation**

The following 3 criteria are decisive for eventual resuscitation measures (see Table 1):

- **Respiration:** present, not present? Gasp-ing? Usually healthy term newborn infants begin to breathe or cry within 60 seconds of delivery.
- **Heart rate:** Determined by feeling for pulsations at the base of the umbilical cord or by auscultation with a stethoscope. Is the heart rate above 60, or above 100 beats/ minute respectively? (See Diagram)
- **Skin colour:** Is the infant centrally pink-ing up? Most newborn infants are initially pale to cyanotic as fetal SaO<sub>2</sub> is around 60–65% and skin perfusion is still diminished. After a few minutes skin colour changes to a generalised pink.

a) Delayed cord clamping (i.e. 30–120 seconds) in premature infants is associated with a higher mean blood pressure and haematocrit, as well as with a lower incidence of cerebral haemorrhage, but not necessarily with a better stability within the first 4–6 hours of life<sup>11)–14)</sup>. This is why no recommendation or concrete time to clamp the cord can be stated when resuscitation is needed<sup>5)</sup>.

	0	1	2
<b>Colour</b>	Body blue or pale	Body pink but extremities blue	Completely pink
<b>Respiratory effort*</b>	Absent	Superficial	Good, crying
<b>Muscle tone</b>	Flaccid	Some flexion of extremities	Well flexed extremities
<b>Reactivity**</b>	No response	Slow	Vigorous
<b>Heart rate</b>	Absent	< 100	> 100

**Apgar Score:** \*Caveat: Assess respiratory effort in ventilated infants with a line (-).  
\*\* Reactivity: spontaneous motor activity, crying, sneezing, coughing

**Apgar Score**

The Apgar Score is a standardised evaluation of the postnatal adaptation and of the success of any resuscitation measures. The Apgar Score however, is inappropriate for making therapeutic decisions.

At 1, 5, and 10 minutes after complete delivery of the infant, every item of the Apgar Score is evaluated and the numbers recorded in the infant’s chart. In case of alterations in the clinical situation or after therapeutic measures, additional Apgar Score assessments can be made.

**Procedures During Normal Adaptation**

During normal adaptation newborn infants breathe spontaneously after delivery, they have a heart rate above 100 beats/minute and rapidly become pink<sup>15), 16)</sup>.

- The newborn infant gets covered with warmed blankets and is laid on the mother’s belly.
- Not every infant needs to be suctioned. If the term newborn infant breathes within the first 60 seconds of life, shows good muscle tone, and if the amniotic fluid is clear, then suctioning of the mouth and pharynx are not warranted. Unnecessary suctioning is uncomfortable for the infant, can cause damage to the mucous membranes, and even lead to reflex bradycardia and apnoea.
- The Apgar Score is assessed at 1, 5 and 10 minutes of life.
- Shortly after delivery the newborn infant is allowed a first breastfeed.

Ideally mother and infant should be allowed continuous skin-to-skin contact during at least 2 hours after delivery, but at the least until after the first breastfeed.

During this time the attending mid-wife or nurse should periodically check up on the well-being of the infant. Routine procedures and further care of the infant should be performed about 2 hours after delivery, or at the earliest after the first breastfeed<sup>17)</sup>. These procedures encompass a first general exam by the mid-wife, obstetrician, paediatrician, or neonatologist. This exam should be done under a radiant warmer and under good lighting conditions.

Further adaptation and body measures are assessed and possible malformations excluded during this first exam:

- **Body measurements:** weight, length, and head circumference (values to be plotted on a growth chart).
- **Respiration:** breathing frequency (norm 30–60 breaths/minute). Are there signs of respiratory distress (retractions, grunting, flaring, cyanosis, tachypnea)?
- **Circulation:** heart rate (norm 100–160 beats/minute). Is the periphery warm and well perfused?
- **Heat balance:** rectal temperature (target temperature 36.5–37.5°C). Assessment of rectal temperature allows for early diagnosis of anal atresia.
- **Malformations:** extremities, genitalia, the back, the palate. Placement of a nasogastric tube to exclude oesophageal atresia or upper intestinal obstruction is only warranted in case of polyhydramnios, of foamy hyper-salivation, or of respiratory distress. One should abstain from systematically probing the nasal airways to rule out choanal atresia. All observations and measures need to be recorded on the baby’s chart<sup>18)</sup>.
  - The skin is cleared of all blood and meconium without completely wiping away the vernix.

- Vitamin-K application, and active and passive hepatitis B vaccination<sup>19)</sup> are performed according to current guidelines. Prophylactic silver nitrate or other disinfecting eye drops are no longer recommended to prevent neonatal gonococcal ophthalmia.

### Procedures in Case of Perturbed Adaptation

#### Resuscitation Scheme

Depending on the condition of the infant, further procedures are performed in addition to the aforementioned measures for a normal adaptation. The possible steps and their respective indications are outlined in the diagram.

#### Commentary on the Individual Steps

##### Heat balance

- Resuscitation should be performed in a heated room. Draught should be avoided; windows and doors should be closed.
- The radiant heater should be switched on 10–15 minutes ahead of the delivery.
- The infant should be quickly dried and transferred to the radiant warmer in warm blankets; wet blankets should immediately be replaced by dry and warm ones.

##### Correct Positioning (see Figure 1)

- Correct horizontal supine placement of the infant, with the head in neutral position with slight extension is important to maintain airway patency. Hyperextension or flexion of the head should be avoided, for this can lead to airway obstruction.
- A small bolster under the shoulders helps maintain airway patency. There are no advantages for lung function to a Trendelenburg positioning of the infant, this should therefore no longer be performed<sup>20)</sup>.

### Flow Diagram: Resuscitation of the Newborn

#### Suctioning

- Use a 10 French gauge (Fr) catheter without side perforations. Use a suction device (oral suction device, mechanical suction device) with a trap (negative pressure should be about -2 m water column, which equals -200 mbar = -150 mm mercury = -20 kPa = -0.2 atm).

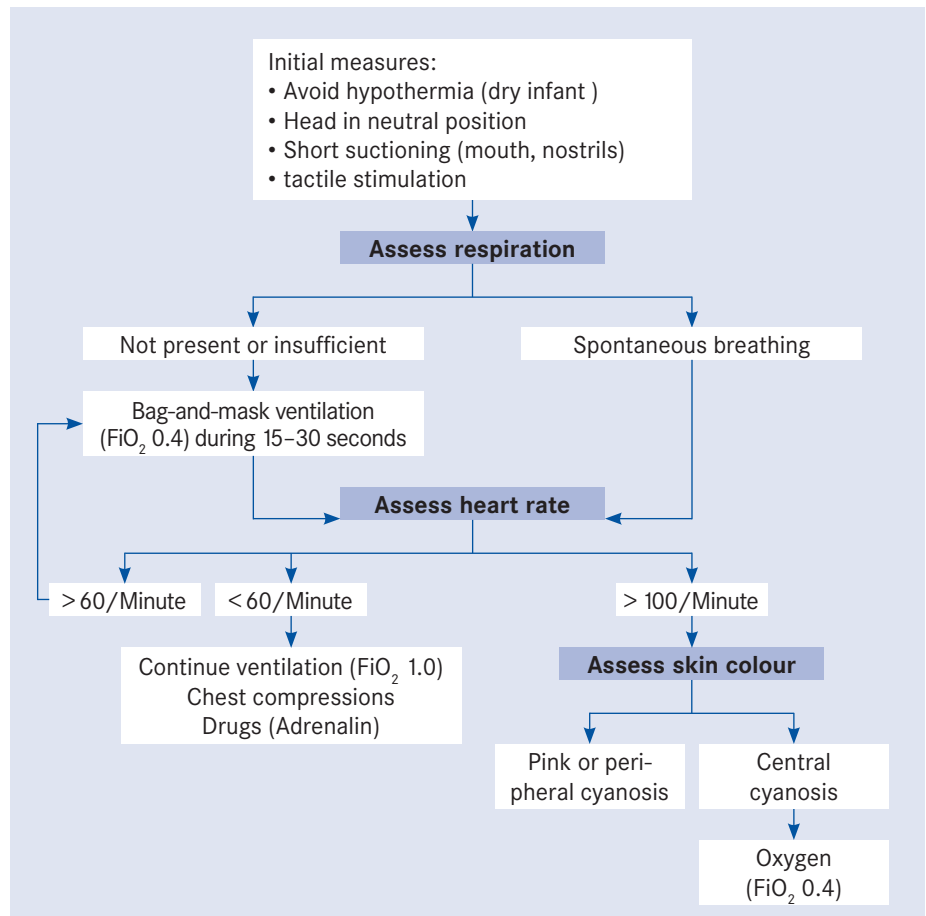


Diagram: Resuscitation of the Newborn

- Suction the mouth and, if necessary, both nostrils.
- Do not insert the catheter into the nose because of risk of injury and swelling of mucous membranes. Newborn infants are obligate nose breathers.
- Caveat: repeated suctioning of longer duration impedes development of spontaneous breathing. Touching the oropharynx can lead to a vagal reflex with bradycardia.
- Any suctioning manoeuvres should last less than 5 seconds. Suctioning of the stomach should only be performed when there is adequate oxygenation, a stable respiratory situation, and under the following circumstances:
  - In case of polyhydramnios, respiratory distress syndrome, or when foamy saliva is present.
  - After or during bag-and-mask ventilation or before a transport.
- If the catheter cannot be advanced into the stomach, oesophageal atresia is highly suspected. In that case the infant should be prone positioned, and the mouth and pharynx regularly suctioned.
- Suctioning of more than 20 ml of gastric fluids is suggestive of upper gastrointestinal obstruction. In that circumstance, a feeding tube should be put in place, the end left open and suctioned every 10 minutes.
- Meconium stained amniotic fluids: intrapartum oropharyngeal suctioning has no influence on outcome of the newborn infant<sup>21), 22)</sup>, which is why this procedure is no longer recommended as a routine in all newborns with meconium stained amniotic fluid. In the rare situation of thick meconium obstructing the upper airways, intrapartum suctioning of the oropharynx may be beneficial. With thick meconium and with a depressed respiration, the meconium should be suctioned by endotracheal intubation before proceeding to bag-and-mask ventilation. Provided the person taking care of the infant has the necessary skills for this procedure, and that the necessary equipment is at hand, the infant should be intubated endotracheally. Tracheal suctioning can be done by

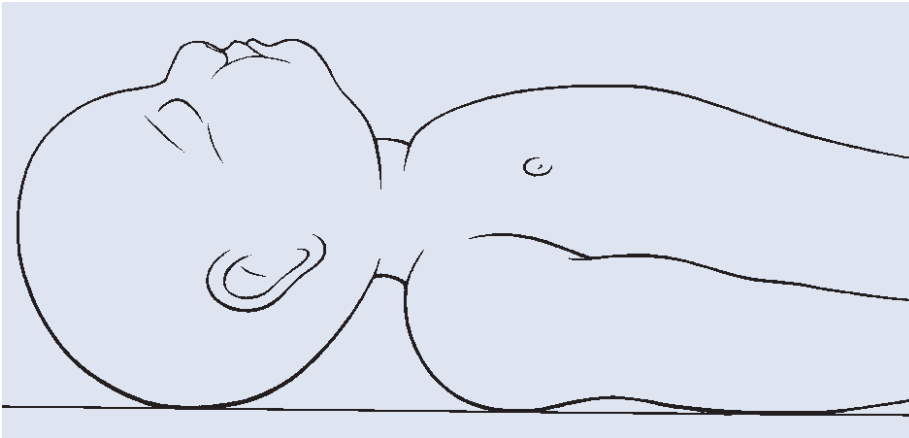


Figure 1: Correct positioning. Modified according to<sup>1)</sup>.

directly connecting the meconium aspiration device on the endotracheal tube to the suction source, and then withdrawn under suction (Figure 2). This procedure with intubation and tracheal suctioning under extubation can be repeated provided the heart rate remains normal. Otherwise, one should proceed to efficient ventilation. Suctioning with a catheter inserted through an endotracheal tube is usually insufficient when thick meconium is present.

### The Role of Oxygen in Newborn Resuscitation

Recent data question the use of pure oxygen ( $\text{FiO}_2$  1.0) in newborn resuscitation, for lower oxygen concentrations or room air ( $\text{FiO}_2$  0.21) have proven just as efficient as oxygen in high concentrations<sup>23)-26)</sup>. There is concern with regard to the possible effects of applying 100% oxygen on respiration, and/or cerebral perfusion. Additionally, potential cell damage due to toxic oxygen radicals is also of concern. In other words, oxygen ought to be considered a medication whose indication and use should be strictly regulated. The large majority of newborn infants do not require additional oxygen immediately after birth. Isolated acrocyanosis in an otherwise reactive newborn with normal heart rate is not an indication for additional oxygen application. To date, the available data is not precise enough to determine an exact oxygen concentration at which resuscitation should be initiated. In light of current knowledge, various authors suggest using oxygen in a concentration somewhere between the two extremes

( $\text{FiO}_2$  0.21 or 1.0, respectively)<sup>27), 28)</sup>. For practical reasons<sup>b)</sup> the Swiss Society of Neonatology proposes to initially use 40% oxygen ( $\text{FiO}_2$  0.4)<sup>c)</sup> and to then adjust the concentration to the needs of the infant according to clinical response and pulse oxymetry<sup>d)</sup>. In case the oxygen requirement exceeds 10 minutes of life, oxygen should be dosed properly and monitored via preductal transcutaneous pulse oxymetry ( $\text{tcSaO}_2$ ). Optimum  $\text{tcSaO}_2$  under additional oxygen should be 90–95% (increase  $\text{FiO}_2$  if  $\text{tcSaO}_2 < 90\%$ , decrease if  $\text{tcSaO}_2 > 95\%$ ).

### Use of Oxygen via Face Mask

When a newborn infant has central cyanosis, shallow breathing, or low respiratory frequency, he should be stimulated and receive free flow oxygen via a face mask (with a flow of 4–5 L/min). The face mask should be held evenly over mouth and nose with a proper seal. Unnecessary movements back

- b) Using 4 L/min 100% oxygen flow through a face mask with side holes or a self inflating bag without a reservoir leads to a final concentration of approximately 0.4  $\text{FiO}_2$ <sup>29)</sup>.
- c) Newborn infants suffering from asphyxia, from pulmonary hypertension or with malformations such as pulmonary hypoplasia (oligohydramnios, diaphragmatic hernia) might profit from higher oxygen concentrations. But data are too scarce to be able to make general recommendations for that purpose<sup>30)</sup>.
- d) More recent data show that preductal transcutaneous oxygen saturation rises from 60% to >90% within the first 10 minutes of life during normal adaptation<sup>15), 16), 30), 31)</sup>. Data with regard to optimal oxygen saturation in case of prematurity, newborn infants with respiratory support, or newborn infants with asphyxia are inconclusive. Due to these constraints, data obtained by use of preductal transcutaneous oxygen saturation during the first 10 minutes of life must be considered as relative indicators only; nevertheless, use of  $\text{tcSaO}_2$  can be an important aid, for if the signal is of good quality the heart rate can be reliably monitored.

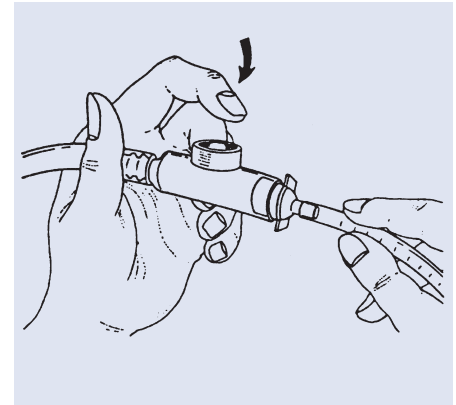


Figure 2: Meconium adapter for intratracheal suctioning.

and forth of the mask will lead to fluctuations in the oxygen concentration. Should there be no adequate response with better respirations, should the cyanosis persist or the heart rate drop below 100 beats/min within 20–30 seconds, then the infant needs to be ventilated.

### Bag-and-Mask Ventilation (Figures 3 and 4)

With insufficient or absent spontaneous breathing, or a heart rate <100/min and/or persistent central cyanosis despite oxygen delivery via face mask, the newborn infant should be ventilated via bag-and-mask. The head is in midline, slightly extended, and the mouth held minimally open. Ventilation is accomplished with individually adjusted pressures and a frequency of 40–60/min. Response to ventilation is monitored by the following criteria:

- Thorax excursions are visible.
- The heart rate increases above 100/min.
- Skin complexion changes to pink.

If continued bag-and-mask ventilation is necessary, a feeding tube should be inserted to allow shunted air to evacuate from the stomach<sup>6)</sup>. The efficacy of a laryngeal mask airway in term newborn infants has been proven; however there is only little data available in premature infants<sup>32), 33)</sup>. Trained personnel, especially in situations where bag-and-mask ventilation or intubation have failed, can consider the laryngeal mask airway an alternative in ventilating term newborn infants<sup>e), 5), 34)</sup>. In most instances, however, bag-and-mask

- e) Not in preterm infants, not during chest compressions or in infants with thick meconium and depressed respiration



Figure 3: Correct positioning of the face mask. Modified according to<sup>1)</sup>.

ventilation will be effective. If necessary, insertion of a Guedel tube can be considered (e.g. Pierre-Robin sequence, choanal atresia). Moreover, acquiring the skill of assisted ventilation is easier than that of intubation.

#### Tracheal Intubation (Figure 5, Table 2)

If after 30–60 seconds of adequate assisted ventilation the heart rate remains below 100 beats/min or if there is absent spontaneous breathing or persistent cyanosis, the infant must be intubated intratracheally. The indication for intubation depends on the clinical situation (as in diaphragmatic hernia), extent of respiratory depression, gestational age, efficacy of bag-and-mask ventilation and finally the experience of the operator. Only a trained person should perform an intubation. Oral intubation is more rapid and easier to perform than naso-tracheal intubation, and this should therefore be the preferred method to remedy an acute hypoxemia and/or bradycardia. Nasal intubation permits better fixation in case of a possible transport, but technically it is more challenging than oral intubation and should not be undertaken in case of acute hypoxemia. If the person doing the resuscitation is not trained in intubating, one should continue to ventilate via bag-and-mask until a person capable of intubating arrives on the scene. During intubation the heart rate should be monitored. An intubation should be interrupted in case of bradycardia, or after 30 seconds at the latest in case of an unsuccessful attempt.

Correct positioning of the endotracheal tube must be verified after each intubation. In most cases this can be accomplished by clinical assessment. End-tidal CO<sub>2</sub> mea-



Figure 4: Bag-and-mask ventilation. **Caveat: The middle finger should be placed on the jaw without putting pressure on the floor of the mouth.**

surement can be of help, provided the equipment and the knowledge in handling the CO<sub>2</sub>-detector are present<sup>f), 5), 35)</sup>.

#### Extubation in the Delivery Room

Premature infants intubated right after delivery should remain so for the transport to the neonatal unit. In the case of term newborn infants, extubation can be considered exceptionally if the cardio-pulmonary situation has normalised, if the infant is pink (pulse oxymetry) and the blood gas analysis is normal. With the endotracheal tube in place, the infant should be ventilated at all times, and a PEEP of 5 cmH<sub>2</sub>O applied. Letting an infant breathe spontaneously through an endotracheal tube can lead to atelectasis.

#### Volume Expansion and Buffering

##### Venous Access

In case of intubation or cardiopulmonary instability in a newly born, intravenous access is mandatory. In urgent cases or when the infant is in shock, umbilical catheterisation is the best option (list 1). Once the cardiovascular system has been stabilised, continuous infusion with Glucose 10% is begun at a rate of 3 ml/kg/h, which corresponds to a glucose supply of 5 mg/kg/min.

##### Volume Expanders

If signs of hypovolaemia or cardiovascular insufficiency are present (as indicated with

f) There is little data about the use of end-tidal CO<sub>2</sub>-detectors in neonatal resuscitation. Evidence of CO<sub>2</sub>-in expiratory air proves endotracheal positioning of the tube; a negative result indicates oesophageal intubation. In case of poor pulmonary perfusion the result might be falsely negative.



Figure 5: Oro-tracheal intubation. Modified according to<sup>1)</sup>.

poor peripheral perfusion, weak pulses, and tachycardia), volume expansion must be applied over 5–10 minutes. The following solutes come into consideration:

- NaCl 0.9% or Ringer's Lactate (initial dose 10 ml/kg, to be repeated depending on blood pressure and clinical signs).
- Packed Red Blood Cells (in case of acute anaemia, use untested O Rh negative blood). Dosage: 10 ml/kg, to be repeated if necessary.

Albumin 5% is no longer recommended as volume expander<sup>36)</sup>.

##### Buffering

In the presence of metabolic acidosis, the aim is to treat the primary cause. Sodium bicarbonate administration can lead to significant side effects (paradoxical intracellular acidosis, osmotically induced myocardial dysfunction, diminished cerebral perfusion, and cerebral haemorrhage especially in premature infants). There is no evidence for the efficacy of sodium bicarbonate in the initial resuscitation of a newly born, and it is no longer recommended in the initial phase of resuscitation<sup>g), 37)-40)</sup>.

##### Chest Compressions (Figures 6a–c)

Adequate ventilation is the most important measure in resuscitation of the newly born.

g) In case of documented persistent severe metabolic acidosis (base deficit worse than 15–20 mmol/L in the blood gas analysis) despite volume expansion, buffering with sodium bicarbonate can be considered at a later point in time and after careful consideration. Sodium bicarbonate should only be given after establishing adequate ventilation<sup>39)</sup>. Dosage: 1–2 mmol/kg over 5–10 minutes (= 2–4 ml/kg of a 4.2% solution containing 1 part NaBic 8.4% and 1 part Aqua dest.), ideally through an umbilical venous catheter. To be repeated according to blood gas result.

Chest compressions are only very rarely needed (<1:1000 deliveries).

Indications for chest compressions include:

- Absent heart sounds (asystole)<sup>h)</sup>.
- Bradycardia less than 60 beats/min despite adequate ventilation with an  $\text{FiO}_2$  of 1.0 for 30 seconds.



**Figure 6a: Chest compressions (both thumbs placed side by side). Caveat: Thumbs should be flexed at the distal joint to enable vertical pressure on the thorax and thereby compression of the heart between sternum and vertebral column.**



**Figure 6b: Chest compressions (Thumbs superimposed).**



**Figure 6c: Chest compressions (compression phase). Caveat: Apply sufficient pressure in order to reduce the antero-posterior thorax diameter by a third.**

h) Assessment of the heart rate by palpation at the base of the umbilical cord, by auscultation, or by palpation over brachial artery after cessation of the umbilical artery pulsations. The use of pulse oxymetry or ECG in difficult situations can be helpful.

Compression technique: both thumbs are placed side by side or superimposed on the lower third of the sternum (beneath a virtual line drawn between both nipples, see figures 6a and 6b), with fingers encircling the thorax. Compression depth should be at least 1/3 of the antero-posterior diameter of the thorax (see figure 6c). Chest compressions can impede effective ventilation, which is why both actions should be coordinated, to avoid simultaneous delivery.<sup>41)</sup> There should be a 3:1 ratio of compressions to ventilations, to achieve 90 compressions and 30 breaths per minute.

#### Discontinuation of Resuscitation

If appropriate resuscitative efforts do not result in spontaneous circulation after 10 minutes (no cardiac activity, no spontaneous breathing), discontinuation of resuscitation may be appropriate, for survival becomes very unlikely or is most likely associated with severe disability<sup>5), 42), 43)</sup>. In case of uncertainty, resuscitation should be continued until a person trained in neonatal resuscitation arrives on the scene and concerted evaluation has occurred before discontinuing resuscitative efforts. After discontinuation the person in charge should contact the neonatal clinic to arrange possible further exams.

#### Laboratory Exams in the Delivery Room

The clinical assessment of adaptation can be complemented by the following «laboratory-triad»:

- Blood gas analysis
- Haematocrit
- Blood sugar level

A blood gas analysis is necessary if umbilical artery pH is <7.15 and in the presence of clinical signs of abnormal adaptation.

The haematocrit should be determined when suspecting of polyglobuly (post term, dysmaturity or peripheral cyanosis), or when anaemia is suspected (pallor, circulatory instability).

Blood glucose levels are determined only if symptoms suggestive of hypoglycaemia are present or in case of diabetic foetopathy. In the early postnatal hours low blood glucose levels are frequent. Measurements of blood glucose levels within the first 2–3 hours of life in asymptomatic newborn infants are

therefore misleading and clinically meaningless<sup>44)</sup>.

#### Postnatal Transport of High Risk Newborn Infants

Whenever possible a postnatal transport should be avoided. Instead, one should strive for a prenatal transfer of the pregnant mother to a hospital with a neonatal intensive care unit.

#### Indications for Transport of Newborn Infants to a Neonatal Unit:

- Premature Infant below 34–35 weeks of gestation.
- Birth weight less than 1800–2000 g.
- Neonatal asphyxia (pH <7.0, BE > -12 mmol/L).
- Resuscitated infant (assisted ventilation > 5 min, intubation, chest compressions, volume expansion, medication etc.).
- Cardio-pulmonary disturbances lasting more than 3 to 4 hours post delivery.
- Persistent or recurrent hypoglycaemia (<2.5 mmol/L with a bedside test) despite early feeds<sup>44)</sup>.
- Suspected neonatal infection (no antibiotics to be given orally or intramuscularly; see group B streptococci recommendations of the Swiss Society of Neonatology)<sup>45)</sup>.
- Seizures, symptoms of drug withdrawal.
- Jaundice at birth<sup>46)</sup>.

This list is not exhaustive; special cases should be discussed with the perinatal/neonatal centre. Newborn infants should be transported by trained neonatal transport teams.

Checklist before transport:

- Mother's and infant's data, resuscitation flow sheet.
- Maternal blood (10 ml EDTA) and cord blood.
- Placenta.
- Call neonatal unit before departure.
- Suction infant's mouth and stomach before transport, insert gastric tube.
- Show infant to mother or both parents if possible before departure.
- Provide the parents with the address and telephone number of the neonatal ward.

#### Care of the Parents

Parental support during the delivery is an important task that is particularly challenging when the newborn infant shows

an abnormal adaptation or is born with malformations. Resuscitation often requires an ample amount of attention, thus impeding mother-infant interaction. Nevertheless, parent-infant contact should be encouraged at all times, even in difficult situations.

Most parents witnessing a resuscitation experience fear and negative feelings. In the immediate acute situation, resuscitation efforts cannot be explained and discussed with the parents. It is thus more desirable to resuscitate the infant in a different room, without the parents. The best-case scenario is to brief the parents before delivery on possible postnatal complications and on their appropriate management. Parental presence during a possible resuscitation can also be discussed at that time.

Even after a difficult resuscitation, there should be sufficient time for a parental briefing, and for the parents to see and touch their child. Before transferring the infant to the neonatal centre, his/her picture should be taken and handed over to the parents. The parents should also receive the address and telephone number of the neonatal ward as well as the name of a contact person. Mother and nurses need to be reminded that the milk production should be stimulated by regular pumping even in a crisis situation.

### Thanks

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## List 1

### Equipment for a Delivery in a Hospital Setting

#### Inventory of the Resuscitation Equipment

- Mobile or fixed resuscitation unit.
- Radiant warmer, warm and draught-free environment.
- Connections for electricity, oxygen/compressed air<sup>i)</sup> and suction.
- Work surface and space for material.
- Access for the transport incubator.

#### Lighting

- Bright light, preferably integrated within the radiant warmer.

#### Heat Source

- Overhead (constant height) controllable radiant warmer with a fixed distance to the pad (do not use red light heater).
- Sufficient warmed blankets/ diapers (do not use electric blankets).
- Preheat resuscitation place early enough.

#### Suction Device

- Mouth-held suction device.
- Suction device with negative pressure set at  $-200$  mbar ( $-20$  kPa, ca.  $-0.2$  atm,  $-2$  mH<sub>2</sub>O,  $-150$  mmHg).
- Suction catheter and tubing connectors.
- Endotracheal tube connector.
- Suction catheter sizes 6.8 and 10 Ch.

#### Oxygen and Gas supply

- Oxygen source with flow meter, oxygen tube to face mask/Ventilation bag.
- Compressed air<sup>i)</sup>.
- Oxygen blender<sup>i)</sup>.
- Pulse oxymeter<sup>ii)</sup>.
- Oxygen face mask.

#### Equipment for Ventilation

- Ventilation bag with a reservoir and a peep-valve; plus one extra bag in reserve.
- Face masks of silicon (sizes 00 and 01); plus one extra set in reserve.
- Laryngoscope with a blade size 0 and 1; plus one extra set with additional bulbs and batteries.
- Endotracheal tubes: sizes 2.5/ 3.0/ 3.5 (mm internal diameter) for oral and nasal application with guide wire.
- Magill forceps.
- Adhesive tape.
- Stethoscope for infants.
- Guedel tube sizes 00/000.

- Ideally every resuscitation unit (as opposed to simple infant warmers in delivery rooms) should have its own oxygen/compressed air outlet, as well as an oxygen blender. Where this is not feasible (only oxygen source), oxygen concentration can be decreased by using a face mask with side holes (with a gas flow of 4–5 L/min, resulting in a FiO<sub>2</sub> around 0.4), or by removing the oxygen reservoir from the ventilation bag (final FiO<sub>2</sub> in the ventilation bag approximately 0.4).
- Transcutaneous oxygen saturation measurement to monitor oxygen application should always be preductal by applying the sensor to the right hand or right lower arm. This is in contrast to the later measured postductal SaO<sub>2</sub> to rule out congenital heart defects<sup>47)</sup>.

### Material for Venous Access

#### Peripheral Lines

- Butterfly catheters 25 and 27 G; venous in-dwelling catheters 24 and 26 G.
- Three-way stopcock.
- Extension (special paediatric size).
- Band-aid.
- Splint.
- 10 ml, 5 ml, 2 ml and 1 ml (Mantoux) syringes.
- Needles (18 G, 1.2.x 40 mm, pink).

#### Umbilical Venous Catheter

- Sterile gloves, different sizes.
- Disinfectant (containing either alcohol or octenidin-phenoxyethanol), sterile swabs.
- Sterile umbilical tray: umbilical tape, sterile drape with open hole, 2 Péan clamps (haemostats), fine and rough anatomical forceps, scissors, needle holder (optional), scalpel, suture (4.0, eventually with atraumatic needle).
- Umbilical vein catheter 3.5 and 5 Ch.

#### Umbilical Vein Catheter Placement (see Figures 7a and 7b)

1. Have assistant hold umbilical cord up.
2. Disinfect skin and umbilical stump.
3. Place sterile umbilical tape around the cord stump with a loose knot.
4. Using the sterile blade, cut off cord stump 1 cm above the skin of the umbilicus.
5. Place sterile drape on the infant with open hole over the cord stump, still allowing for infant to be observed.
6. Locate the umbilical vein and the 2 umbilical arteries.
7. Using haemostats (Péan clamps) to stabilise the stump, clamp the Wharton's Jelly and insert the catheter (usually 5 Ch), which has been flushed with 0.9% NaCl beforehand, into the vessel lumen.
8. The catheter should be advanced to the appropriate length according to the size of the infant. In the emergency a depth of 4–5 cm is sufficient (check by aspirating blood).

#### Further Equipment

- Umbilical cord clamps.
- Gastric tube 4 and 5 Ch.
- Venous in-dwelling catheters 18 and 20 G (for drainage in the event of a pneumothorax).
- Apgar timer (possibly a stop watch).
- Tape measure.
- Thermometer.

### Fluids

- 10% Glucose, 100 ml bottles and 10 ml vials.
- 0.9% NaCl, 100 ml bottles and 10 ml vials or Ringer's Lactate 100 ml bottles.

### Drugs

(See Table)

Drugs are very rarely needed for neonatal resuscitation. If any cardiovascular support is needed, it is usually based on volume expansion, or on rare occasions on adrenalin (epinephrine)<sup>5)</sup>.

### Adrenalin 1: 1000 (1 mg/ml)<sup>k)</sup>

Dosage: 10–30 micrograms/kg/dose IV (corresponds to 0.1–0.3 ml/kg of a 1:10,000 adrenalin solution; 1 ml of a 1:1000 adrenalin solution + 9 ml of 0.9% NaCl) or 30–100 micrograms/kg/dose if given endotracheally<sup>5)</sup>.

### Naloxone (0.4 mg/ml)

There is no evidence to support the use of naloxone to reverse neonatal respiratory depression caused by opioids. Furthermore, it is unknown if naloxone can reduce the need for mechanical ventilation in the delivery room. Long-term safety is questionable too; therefore naloxone cannot be recommended routinely in respiratory depressed newborn infants in the delivery room<sup>48)</sup>. The first line treatment consists in respiratory support and mechanical ventilation.

Possible indication: newborn infants whose mothers have received opioids within 4 hours of delivery. Dosage: 0.1 mg/kg IV or IM (not to be given endotracheally or subcutaneously)<sup>l)</sup>. The half-life of naloxone is usually much shorter than that of opioids, which is why infants must be monitored during the first 24 hours after its administration.

k) No data exist regarding high dose adrenalin therapy (100 µg/kg/dosi) in newborn infants<sup>39)</sup>. Therefore and because of potential side effects, this dosage is not recommended. Adrenalin should be used if there is no increase in heart rate > 60/min after 30 seconds of adequate ventilation and chest compressions. Although intubation is usually performed before placement of a venous line (umbilical venous catheter) in neonatal resuscitation, the intravenous administration of adrenalin should be favoured over the intratracheal route. The normal dosage should be chosen if adrenalin is to be given repetitively.

l) The AAP recommended dosage of Naloxone of 0.1 mg/kg is not evidence based<sup>49)</sup>.



Figure 7a: Cutting stump 1cm from the skin of the umbilicus.

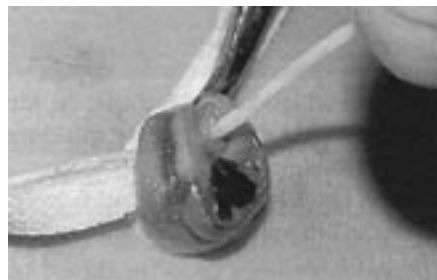


Figure 7b: Umbilical vein cannulation with a catheter.

Contraindication: infants of opioid dependent mothers (check history!).

Caveat: Naloxone-Neonatal (0.02 mg/ml) should no longer be used.

### List 2

#### Minimally Required Equipment for a Home Birth

- Telephone connection (numbers of ambulance and closest hospital at hand).
- Heated room and good lighting conditions.
- Table with padded surface on table height.
- Towels and gloves.
- Mouth-held suction device.
- Ventilation bag (e.g. Baby-Ambu or Laerdal-bag, with oxygen reservoir) as well as masks (Laerdal masks sizes 00 and 01).
- Oxygen face mask and oxygen connecting tube.
- Oxygen bottle with a flow meter (flow of up to 6–10 L/min).
- Pulse oxymeter.
- Resuscitation flow sheet.
- Cord clamp, cord scissors.
- Stop watch.
- Stethoscope.
- Thermometer.
- Bedside blood glucose measuring device.

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Endotracheal Tube			2 kg, 34 weeks of gestation	3 kg, 37 weeks of gestation	4 kg, 40 weeks of gestation
Tube size			ID 3.0	ID 3.5	ID 3.5
Insertion depth at lip (cm)			8	9	10
Insertion depth at nose (cm)			9.5	10.5	11.5
Medication	Dose	Preparation/Indication	2 kg, 34 weeks of gestation	3 kg, 37 weeks of gestation	4 kg, 40 weeks of gestation
Adrenalin 1:1000 (1mg/ml vial)	10–30 mcg/kg iv	1 ml + 9 ml NaCl0.9% (1:10000 ie 1ml = 100 mcg)	0.2–0.6 ml	0.3–0.9 ml	0.4–1.2 ml
NaCl 0.9% Ringer's Lactate	10 ml/kg	Volume bolus	20 ml	30 ml	40 ml
Glucose 10%	4–6 mg/kg/ min 2 ml/kg	Glucose infusion Symptomatic hypoglycaemia	6 ml/h 4 ml	9 ml/h 6 ml	12 ml/h 8 ml

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