OBSTETRIC HEMORRHAGE

by T. Ogburn and W. Haffner

Vaginal bleeding during the second half of pregnancy must be considered to be abnormal and a sign of potential maternal and fetal jeopardy. Although the bleeding may originate from the cervix or vagina, the best practice is to assume that the bleeding is of uterine origin until such time that it can be disproved.

Digital or speculum examinations of the vagina may on occasion result in copious hemorrhage, especially if there is placental tissue in the area of the internal os of the cervix. Therefore all digital and speculum examinations should be avoided until placenta previa has been ruled out by an ultrasound examination. Significant bleeding mandates thorough evaluation of both the mother and fetus.

I. PLACENTA PREVIA

While implantation of the fertilized ovum may occur anywhere within the uterine cavity, low implantation may result in placental tissue partially or completely occluding the region of the internal cervical os. Although this can occur in any gestation, it is seen more commonly in multiparas, multiple fetuses, and in patients with previous cesarean section or other uterine surgery. The incidence of placenta previa at term is approximately 1 in 200 pregnancies. However, it is found much more frequently (approximately 1 in 10-20) in the midtrimester by ultrasound examinations of asymptomatic women. These women should have a repeat ultrasound at approximately 28 weeks to reassess the location of the placenta. They do not need to follow any special precautions unless they become symptomatic.

Types of Placenta Previa

- Central (Total Placenta Previa)

  The placenta extends into the anterior and posterior lower uterine segments and totally occludes access to the internal cervical os. Cesarean delivery is mandatory in order to prevent major obstetric hemorrhage.

- Partial Placenta Previa

  The placenta partially overlies the internal cervical os, such that when detected near term cesarean section is almost always necessary.

- Marginal Placenta Previa

  The placental edge extends to, but not over, the region of the internal cervical os. The relationship between this leading edge and the internal cervical os may change for the better as the gestation advances because the placental tissue may be “pulled upward” (migrate) toward the uterine fundus as a result of the ascension of the muscle fibers of the lower uterine segment. In this situation, vaginal delivery is possible under carefully monitored conditions with cesarean section capability immediately available.

Presentation of Patients with Placenta Previa

The vaginal bleeding is almost always painless and typically occurs initially between 24 and 36 weeks gestation. The blood loss may range from minor to profuse hemorrhage.

- The uterus is usually soft and indentable, although 10% have concurrent abruption and 25% will develop signs of labor.

- The presenting part is usually high on abdominal examination.
- Breech, oblique, or transverse lies are much more frequently encountered (1 in 3).

Principles of Management *

Patients with unexplained vaginal bleeding after 20 weeks of gestation should not undergo vaginal or cervical examination until the obstetric team is fully prepared to assess the patient appropriately and manage any potential complications. Patients suspected of having placenta previa should have a thorough ultrasound examination to delineate the inferior extension of the placental tissue. If the initial blood loss is heavy, blood should be cross-matched and transfused if necessary to maintain the maternal hematocrit at >30. Immediate transfer to a high risk tertiary care facility is indicated if the fetus is significantly premature. Infants near term may be followed locally only if cesarean section delivery can be promptly accomplished on a 24-hour-a-day basis. Strong consideration should be given for delivery in patients >37 weeks. Rhogam should be considered for Rh-negative patients.

Most obstetricians feel that continued vaginal bleeding indicates continuing risk of jeopardy for the fetus, and that the fetus should be delivered when maturity can be documented by amniocentesis. While awaiting maturity in a patient with ongoing bleeding, the patient should be kept at relative bed rest, preferably in the hospital. Management as an outpatient may be appropriate for patients who are stable with no further bleeding. Tampons, vaginal examinations, and coitus are contraindicated. Once the fetus has reached maturity or if the bleeding continues to a point where it poses a significant risk for the mother, a cesarean delivery should be performed. If a marginal or partial previa is suspected then a "double set-up exam" may be performed (examination in an OR prepared for immediate cesarean delivery if hemorrhage occurs). Preterm patients should be considered for steroid treatment.

Steps in the management of an actively bleeding patient with placenta previa include:
• Hospital-based evaluation with cesarean delivery capability available • Insert large-bore IV line(s) • Stat type and crossmatch blood • Monitor serial hematocrits, vital signs • Transfer to tertiary center if premature, or facility with cesarean delivery capability if near term. • Evaluate fetal status • Ultrasound for placental localization • Double set-up examination if ultrasound findings are unclear and obstetric conditions warrant delivery • Cesarean delivery for total or significant marginal previa • Expectant management if bleeding subsides and fetus is immature • Steroids if premature • Consider tocolysis if premature or for transport

II. ABRUPTIO PLACENTA

Abruptio placenta refers to the premature separation of the normally implanted placenta prior to the birth of the fetus. While symptoms may not be evident until 40-50% or more of the placental surface area has separated from its uterine attachment, placental abruption constitutes a major threat for both mother and fetus.

Abruptio placenta occurs in approximately 1% of deliveries and is extensive enough to kill the fetus in 0.2% of deliveries. The condition is seen more frequently in association with hypertensive disorders (chronic and pregnancy induced), abdominal trauma, grand multiparity, heavy cigarette smoking, uterine anomaly (including fibroids), unusually short umbilical cord, preterm PROM, and cocaine use. A woman who has a previous episode of abruptio placenta has a 10-fold greater risk of recurrence.

Clinical Characteristics of Abruptio Placenta

- Vaginal bleeding may be external, concealed behind the placenta, or a combination of the two.
- The onset of symptoms is generally sudden, with the patient complaining of local or generalized uterine pain.
- The uterus may be rigid and tender to palpation and may visibly enlarge under observation.
- The amniotic fluid often exhibits a port wine color.
- Fetal distress may occur as the degree of abruption increases.
- Ultrasound examination is not reliable in identifying retroplacental blood clots.
- Shock may occur out of proportion to the observed external blood loss.
- Disseminated intravascular coagulation is a common complication with significant abruption.
- The patient may be entirely asymptomatic if less than 50% of the placental surface has separated.

Principles of Management *

The patient suspected of having abruptio placenta demands intense, continuous observation and monitoring. Vital signs should be recorded frequently, at least every 15 minutes, until it is certain that the mother and fetus are stable. The height of the uterine fundus should be measured and marked immediately upon admission so that subsequent enlargement can be documented. Continuous fetal heart rate monitoring should be utilized. A large bore intravenous line should be established. Laboratory studies include a complete blood count, type and cross-match, and possibly blood coagulation studies (platelets, fibrinogen, PT, PTT, fibrin degradation products). A red-stopper tube (without additives) may be taped to the head of the bed in order to directly observe clot formation and possible clot lysis. If full obstetric surgical capabilities are not immediately available, the patient should be evaluated for transport to a facility which can provide the full range of services required. Tocolysis is controversial but may be considered, especially for stabilization for transport.

Ultrasound should be performed to rule out the presence of a placenta previa.

Once placenta previa has been excluded, an examination of the vagina and cervix should be performed to exclude direct trauma or infection as a possible cause of the bleeding.

If the bleeding appears to be from the uterus and the patient is in labor, vigilant observation is mandatory as up to 60% of patients will develop fetal distress. Immediate Cesarean delivery should be performed if the maternal or fetal condition deteriorates.

If the patient is not in labor and both the mother and fetus are stable, expectant management is appropriate. Where possible, the patient should be hospitalized at bed rest and serial hematocrits and coagulation studies obtained. Fetal well-being should be assessed. Steroids should be considered for premature patients. In patients who have cessation of bleeding and remain stable, outpatient management can be considered. These patients should have serial

ultrasound examinations to assess fetal growth and assessment of fetal well-being should be obtained twice weekly. Strong consideration should be given to delivery when patients reach term, as a significant number of abruptions will recur.

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PREMATURE RUPTURE OF MEMBRANES

by T. Ogburn and W. Haffner

Rupture of the fetal membranes prior to the onset of labor occurs in 10-12% of all deliveries. Generally, the rupture occurs spontaneously and for unknown reasons. When the membranes rupture prematurely at term, expectant management will result in labor in 50% patients within 5 hours and in 95% within 28 hours.

Of patients with preterm (<35 weeks) premature rupture of the membranes, only 45% will be in labor within 24 hours and 62% within 48 hours. Managed expectantly, 75% of these patients will deliver within one week. This very common obstetric management problem accounts for 20% of all premature births and 3% of all maternal deaths and leads to a perinatal mortality of 43 per 1,000 births largely due to prematurity and sepsis.

Diagnosis of PROM

- History of leakage of fluid.
- Direct visualization of fluid coming from the cervix or pooled in the vagina by a single sterile speculum examination.
- Amniotic fluid arborization (ferning).
- Alkaline reaction (blue) using nitrazine paper.
- Oligohydramnios when recent prior ultrasound examination revealed normal fluid volume.

Clinical considerations with PROM:

- Predisposing factors include incompetent cervix, hydramnios, multiple gestation and infection.
- PROM is associated with an increased risk for abnormal fetal position such as breech or transverse lie.
- There is an increased danger of prolapse of the umbilical cord if the presenting part is not engaged into the pelvis.
- The major fetal risks of PROM at 34 weeks or earlier are prematurity and infection.
- The major maternal risk of PROM is infection.

Principles of Management of PROM:

Management of the patient with premature rupture of the membranes may vary somewhat from institution to institution. The following guidelines are generally appropriate within the IHS:

Management of PROM	
Gestational Age/Weight	**Management**
A) >36 wks or >2500 gms	1) Anticipate delivery within 24–48 hours
	2) Confirm vertex presentation clinically or with ultrasound
	3) Assess for cord compression and/or prolapse using FHR monitoring and speculum exam
	4) Monitor fetus. Fetal tachycardia is a sensitive indicator of developing intrauterine infection
	5) Obtain Group B strep culture from vagina/perineum and use antibiotic prophylaxis per local policies
	6) **Do not perform digital exam unless indicated (e.g. fetal distress)**
	7) Deliver if chorioamnionitis develops. Inductions should only be performed at facilities with cesarean delivery capability and qualified personnel
B) 34-36 wks or 2000–2500 gms	1) Consult and consider transport to facility capable of care of preterm infant. Better to transport prior to onset of labor, infection, etc.
	2) Obtain fluid from the vaginal vault for phosphatidyl glycerol (PG) analysis to assess fetal lung maturity.
	3) As above #2–7
C) < 34 wks or < 2,000 gms	1) Transport to tertiary facility if mother and fetus are stable for transport
	2) No cervical exams
	3) Consider treatment with steroid.
	4) Tocolysis may be considered for transport.

Expectant management of patients with premature rupture of the membranes prior to 36 weeks gestation requires adherence to several clinical principles in order to assure maximal safety for the mother and fetus. **Only a single speculum examination to confirm the diagnosis of PROM should be performed and there should be no palpation of the cervix.** The patient should be at bed rest in the hospital where her temperature is monitored at least every 6 hours, serial white blood cell counts with differentials are performed, and the volume and character of the amniotic fluid are observed. The amniotic fluid should remain clear and odorless. Nonstress testing or biophysical profiles are indicated daily. Early delivery is indicated for maternal fever, rising WBC, or the development of a mal odor to the fluid. Continued normal fetal growth should be assured and intrauterine growth retardation ruled out. Douching, coitus, and use of tampons are contraindicated. Outpatient management may be considered in select cases in consultation with a specialist.

The question of prophylactic antibiotic use is frequently raised because of the significant risk of amnionitis (from 20% at birth weight less than 2,500 gm to 36% below 1,800 gm to 49% below 1,000 gm). Two meta-analyses have concluded that antibiotics are beneficial in decreasing complications of preterm PROM. No single regimen is clearly more efficacious. One suggested regimen is IV ampicillin and erythromycin for 48 hours followed by oral meds for an additional 5 days if the patient remains undelivered. Initiation of prophylactic antibiotics should be done in consultation with the regional referral center. Prophylactic antibiotics have been shown to be beneficial for cesarean delivery in the presence of PROM. **Aggressive antibiotic therapy and early delivery are indicated if amnionitis develops.**

Corticosteroid treatment should be considered for patients <34 weeks to reduce the incidence of RDS.

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PREMATURE LABOR

by T. Ogburn and W. Haffner

Premature or preterm labor is defined as the onset of labor (with progressive cervical effacement and dilation) prior to completion of the 37th week of gestation. Infants weighing less than 2,500 gm at birth are defined as being of low birth weight and they may or may not be premature as well.

Reducing the number of premature babies is an important goal of obstetrics since prematurity accounts for more than 75% of all perinatal morbidity and mortality worldwide. However, despite considerable attention, the ~ 10% incidence of preterm birth in the U.S. has remained essentially unchanged over the past 40 years. This may be due in part to the difficulty in identifying patients in true preterm labor who are at risk for delivery. In general preterm labor may be defined as >6 contractions/hour and/or cervical change prior to the completion of the 37th week of gestation.

Predisposing factors to prematurity include:

- A **previous preterm delivery**, which increases the risk 3-fold in the current pregnancy.
- Polyhydramnios.
- Multiple gestation.
- Chronic maternal diseases such as hypertension, toxemia, drug addiction (esp. cocaine), and cigarette smoking.
- Acute maternal illness such as pyelonephritis, chorioamnionitis, or peritonitis.
- Cervical incompetence.
- Uterine anomalies or leiomyomata.
- Abruptio placenta or placenta previa.
- Short interval between pregnancies.
- No or inadequate prenatal care.
- Poor socioeconomic status.
- Inadequate maternal weight gain.
- Premature rupture of membranes.
- Elective induction of labor or elective repeat cesarean delivery.
- Preeclampsia.

Prevention of Preterm Labor/Delivery

Despite much research no approach to prevention of preterm labor/delivery has been shown to be clearly effective. Home uterine activity monitoring, prophylactic tocolysis, serial cervical exams, screening for risk factors, intensive education programs, cerclage, and modification of daily activities have all been utilized, sometimes at great expense and inconvenience, without clear demonstration of benefit. Approaches should be individualized to the service unit and their experience with their patient population with the above in mind. Recent studies have suggested screening for and treating bacterial vaginosis may decrease the incidence of preterm labor, especially in high-risk populations.

Principles of Management of Preterm Labor

Management of preterm labor is often a complex process requiring the utilization of considerable resources, including skilled personnel, time, equipment, and supplies. Every attempt should be

made to deliver preterm infants at a facility best equipped to care for them. Transport should be accomplished as rapidly as possible for patients deemed to be in labor and at risk for delivery.

A number of requirements must be met in order to consider attempting to arrest preterm labor since not all fetuses will benefit from prolonging their intrauterine stay:

- Gestational age <36 completed weeks with good dating
- Estimated fetal weight <2,500 g
- Intact membranes
- Cervical dilatation <4 cm
- Absence of severe pre-eclampsia, intrauterine infection or ruptured membranes
- No maternal contraindications to the proposed treatment, which may include:
  - Cardiac disease
  - Diabetes Mellitus
  - Uterine anomaly or tumor
- No fetoplacental contraindications to treatment, which may include:
  - Abruptio placenta
  - Intrauterine growth restriction
  - Fetal anomaly
  - Fetal death
  - Fetal distress

Initial Steps in Management of Preterm Labor *

- Estimate the gestational age by careful review of the available records and current examination
- Evaluate the maternal and fetal condition
- Assess the available pediatric support, nursing staff, equipment and supplies. Consult with the regional referral center to plan for active management or possible maternal transport to the regional center
- Consider hydration at bed rest for initial management
- Fetal fibronectin testing has been approved by the FDA. It may prove helpful in identifying patients not at risk for delivery

Advanced Management of Preterm Labor – In Patients Who Are Determined To Be In Preterm Labor and Are Unresponsive To Conservative Measures: *

- Consider priming of pulmonary maturity of the preterm fetus with corticosteroids. Betamethasone (Celestone) 12 mg IM can be given in order to attempt to accelerate fetal lung maturity between 28 and 32-34 weeks. A second dose is given 24 hours later. Alternatively dexamethasone may be used at a dosage of 6mg IM every 12 hours x four doses. In general any patient being considered for tocolysis should be given steroid therapy.
- Consider administration of a tocolytic agent. After consultation with the regional referral center, use of one of the following agents may be indicated in order to attempt to arrest the preterm labor. Though tocolytics have not been clearly shown to significantly prolong gestation they may be quite useful to arrest labor for transport and administration of steroids.

B_2-sympathomimetic drugs. Each of the drugs effectively suppresses uterine activity in approximately 80% of patients in preterm labor. Increased maternal glucose and insulin levels and decreased plasma potassium levels are common metabolic effects. The most common maternal side effects are palpitations, tremor, and nausea. During maternal treatment, fetal tachycardia may develop. Ritodrine (Yutopar), the only FDA-approved drug for this indication, and terbutaline (Brethine) are the drugs most commonly used in the U.S. The protocol of the regional referral center should be used for the administration of the selected B_2-agonist.

Magnesium sulfate. A number of centers have had equally good experience using $MgSO_4$ in similar dosages as given for preeclampsia (4-6 gm loading dose given by slow IV push followed by 1-3 gm/hour IV maintenance).

Other drugs. Prostaglandin synthetase inhibitors such as indomethacin are also effective, but they can lead to premature closure of the ductus arteriosus and oligohydramnios. Calcium channel blockers such as nifedipine are being used more commonly as a second line agent. Use with $MgSO_4$ is contraindicated as profound hypotension may result. Use of these agents should be in consultation with a high risk specialist.

Preparation for Delivery

If the labor cannot be arrested and there is insufficient time for safe maternal transport to a regional perinatal center then careful planning for the delivery is essential.

- Formulate a plan of management
- Utilize continuous fetal heart rate monitoring
- Treat infection promptly
- Prophylaxis for Group B strep during labor is indicated unless culture within one week is negative
- Avoid over stimulation of the uterus
- Minimize analgesics near delivery to avoid depression of the neonate
- Move the patient to the delivery room early so that the team, including the pediatrician, is adequately prepared
- Use episiotomy and/or forceps only for usual indications
- Initiate prompt resuscitation efforts as needed

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POST-TERM PREGNANCY

by T. Ogburn and W. Haffner

Post-term pregnancy, by definition, is a gestation of 42 weeks or more (294 days or more from the first day of the last menstrual period). **Postmaturity,** or the **postmaturity syndrome**, refers to the clinical syndrome involving the post-term neonate who shows signs and symptoms attributable to the advanced gestational age and prolonged exposure of the skin to amniotic fluid (e.g. long fingernails and peeling skin). In more advanced cases, signs of dysmaturity resulting from utero placental insufficiency may occur, including muscle wasting and meconium staining of the skin and nails.

Clinical Significance of Post-Term Pregnancy

Post-term pregnancies occur in ~ 5% of all gestations, yet they account for >10% of all perinatal morbidity and mortality. In addition, postdates pregnancies are the leading indication for antepartum fetal heart rate testing at a significant cost in terms of personnel and resources.

Etiology of the Post-Term Pregnancy

- Wrong dates

  A majority of apparent post-term pregnancies result from inaccurate dating. Assessment of gestational age is reviewed in the Prenatal Care portion of the manual. In general an EDC should be determined long before concerns of post-datism arise. If there is a question of the EDC in a patient possibly post-term, choose the EDC that makes the patient further along. This will avoid missing a post-dates pregnancy and the adverse outcomes that may be associated with it.
- Unknown

  Possibly just a normal variant.
- Fetal Anomalies

  Anomalies, especially neural tube defects, often result in prolonged pregnancy.

Anticipated Complication of Post-Term Pregnancy

1. **Maternal**

   Emotional Strain. Patients and families are often frustrated and anxious when the pregnancy goes post term. Their feelings should be considered when management decisions are made and implemented.

   Iatrogenic. Patients are subjected to the increased cost, risks and inconvenience of antepartum testing, induction of labor, and a higher incidence of cesarean delivery.
2. **Fetal**

   Perinatal morbidity and mortality increase significantly as the pregnancy progresses beyond 42 weeks. Mortality is 2 times greater between 42-43 weeks and 4 times greater between 43-44 weeks. Most complications are related to deteriorating placental function which reaches its maximum level at ~ 38 weeks and declines steadily after that. As the placenta ages, blood flow decreases on both sides, with resulting decreased gas exchange, nutrient delivery, and waste product clearance from the fetus. The fetus may then begin to consume his or her fat, protein, and glycogen reserves. The result is loss of subcutaneous fat tissue, muscle wasting, and poor tolerance of the stress of labor due to decreased reserves of glycogen. The fetus may have a decreased urine output resulting in decreased amniotic fluid. The associated lower O_2 saturation of blood returning to the fetus may cause centralization of the circulation with reduced blood flow

to less essential organs of the body such as the gut, and the resultant hyperperistalsis and anal sphincter relaxation. This results in passage of meconium. Cord compression during labor may result in further vagal stimulation and passage of meconium as well as fetal gasping which can result in utero aspiration.

Oligohydramnios. Fluid volume is approximately 50% of its peak level at 42 weeks and only 20% by 44 weeks. The decreased fluid volume may result in thicker meconium and cord compression during labor.

Meconium. Approximately one third of post-term pregnancies will be complicated by meconium. Most infants will not develop meconium aspiration syndrome if managed appropriately (see below).

Macrosomia. Many post-term infants will continue to grow normally even though they are post dates. The incidence of macrosomia (>4,000 gms) increases 2-3 fold at 42 weeks relative to term. Problems that may arise from a macrosomic fetus include cephalopelvic disproportion and a higher cesarean delivery rate, increased trauma to the birth canal, and shoulder dystocia.

3. **Neonatal**

Meconium Aspiration Syndrome. A relatively uncommon complication of meconium stained fluid but a serious cause of morbidity and mortality when it occurs. Management of meconium is discussed in the Perineal Asphyxia chapter.

Post Maturity Syndrome. Clinical manifestations of the postmaturity syndrome can be categorized in 3 groups as follows:

a. Skin changes resulting from absence of protective vernix (which reaches its peak at 37 weeks and progressively decreases in quantity thereafter) and prolonged exposure to amniotic fluid. Wrinkled or macerated skin at birth, best seen on the hands and feet giving a “soaked in water” or “washer-woman hands” appearance. The skin of the palms and soles will appear baggy, wrinkled, and elevated in large folds.

   Cracked, parchment paper-like skin, which when it dries out after birth may flake off or desquamate in larger sheets.

   Absence of vernix caseosa, or the cheesy skin coating normally still present in the protected areas of the axillae and groin in the term newborn.

   Pale appearance of the skin, due to its increased cornification with age and the lifting-off of the upper layers of epidermis.

b. Physical signs due to advanced gestational age:

   Increased alertness (if the infant was not severely asphyxiated), giving the post-term newborn a “wide-eyed,” “mature” look. This reflects the advanced sensory development that accompanies “2-week,” “3-week,” or “4-week-old” infants.

   Long, curved fingernails and toenails, which have continued to grow in utero.

   Abundant, long hair with each strand tending to stand alone rather than in clumps as is true of the premature infant.

c. Signs resulting from *chronic* or *late-onset placental insufficiency* (i.e., dysmaturity), or from perinatal asphyxia:

   Reduced subcutaneous fat tissue, giving a “loose-skin appearance.” The loose skin is especially apparent over the thighs and buttocks.

Disproportional reduction in birth weight compared to length and head circumference plotted on the normal fetal growth charts (see section of Intrauterine Growth Restriction).

Meconium staining of the skin, nails, and cord. The staining tends to be green-tinged if the passage of meconium was recent, whereas it tends to be more yellow-tinged if passed more than 6 hours prior to delivery (reflecting an oxidation process of its bilirubin component).

Principles of Management of Post-Term Pregnancy

The goal of management of the post-term pregnancy is to deliver a healthy baby to a healthy mother. Post-dates patients should have assessment of fetal well being initiated between 41-42 weeks. In general, patients who have completed 42 weeks gestation should be induced. Exceptions are those patients with a non-inducible cervix who have uncertain dating. If a pregnancy is continued beyond 42 weeks, fetal well-being should be documented twice weekly with induction initiated when the cervix becomes favorable or testing is not reassuring.

Once labor has begun, all post-dates patients should be monitored closely. Continuous monitoring should be employed in patients with meconium or fetal heart rate abnormalities. Special attention should be given to the findings of reduced or absent fetal heart rate variability and the presence of variable decelerations as signs of complicating placental insufficiency or cord compression. Keep in mind that the post-date fetus often does not have normal reserves and may not tolerate the stress of labor and delivery well.

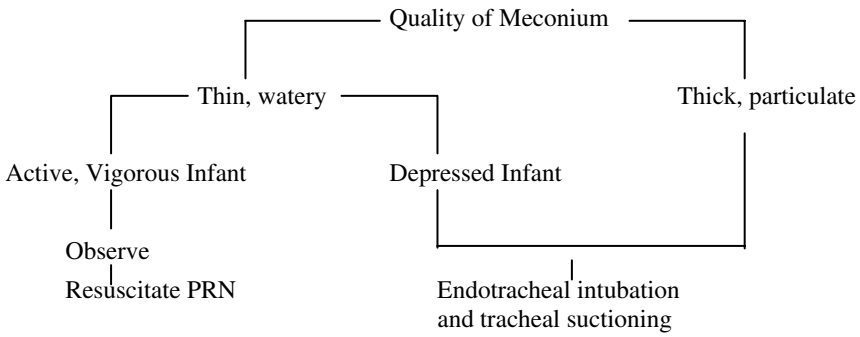
If macrosomia is suspected, the labor curve needs to be examined with great care. Arrest of dilation or arrest of descent may be the first signs of cephalopelvic disproportion (CPD). **Preparation should be made for possible shoulder dystocia.** Vacuum or forceps delivery should be performed very cautiously on the post-date, possibly macrosomic fetus.

When meconium is present or suspected a combined obstetric and pediatric approach will be most effective in preventing meconium aspiration syndrome. If ruptured membranes are suspected, or AROM is performed and no fluid is identified, *assume that thick meconium is present.*

The following steps should be followed in the management of meconium.

- Amnioinfusion should be considered for moderate to thick meconium. This will dilute the meconium as well as prevent cord compression that may cause fetal gasping and in utero aspiration.
- A pediatrician or other person(s) competent in the techniques of newborn resuscitation (see section on Resuscitation of the Asphyxiated Newborn) should be notified in time to be present when the mother is taken to the delivery room.
- As soon as the baby's head appears on the perineum or through the uterine incision, and before the baby's first breath, a DeLee trap or other suction catheter should be passed through both the nares to clear them of meconium and then through the mouth to suction as far back as the hypopharynx.
- Immediately after receiving the baby, the person designated to carry out the resuscitation suctions the baby's nose and oropharynx with a bulb syringe and/or a DeLee catheter. Stethoscope monitoring of the infant's heart rate, plus oxygen delivery through a tube pointed at the mouth and nose by an assistant, is provided throughout the entire procedure. At this point a decision needs to be made as to whether endotracheal intubation for the purpose of suctioning meconium from the trachea is necessary. There is some variability in clinical practice. American Heart Association and American Academy of Pediatrics

guidelines for Neonatal Resuscitation (1994) recommend the following approach:



For the depressed infant, or if thick particulate meconium is present, suctioning should be done via an endotracheal tube; use of a DeLee suction catheter is not recommended. Suctioning should be done using a meconium aspirator attached to wall suction with vacuum pressure set at about 100 mm Hg. Re-intubation followed by suctioning should be repeated. Judgment is needed to determine how long and how many intubations are performed. If the infant is severely depressed positive pressure ventilation may need to be started even if some meconium remains in the airway.

- If respiratory distress symptoms increase along with the patient's oxygen requirements, arrangements for transfer to a tertiary care institution should be initiated and the infant closely monitored for signs of air-trapping and air-leak. Arterial blood gas monitoring through an umbilical artery catheter or repeated radial artery sticks is required and bicarbonate correction of metabolic acidosis considered. Liberal use of oxygen with only cautious reduction at signs of improvement is always indicated, and poses no risk to the infant's eyes (in the sense of developing retrolental fibroplasia or RLF) since we are dealing in this case with a mature (even post-mature) infant. To allow these infants to become hypoxemic is to further predispose them to develop PFC and respiratory failure.*

Anticipated Outcome

Through a combined and well prepared team approach, morbidity and mortality for both the baby and mother should approach normal levels.

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NEONATAL RESUSCITATION

by T. Harris

GENERAL CONSIDERATIONS

The whole area of newborn resuscitation has been revitalized by the development of a standardized (but periodically updated) Neonatal Resuscitation Program (NRP) sponsored jointly by the American Heart Association (AHA) and the American Academy of Pediatrics (AAP). This superb teaching program is comprised of a comprehensive textbook and concise instructor's manual (now both in their 4th edition), as well as interactive multimedia CD-ROMs, a videotape, slide presentations, and other materials. (For a complete listing of NRP teaching materials available for purchase from AAP, their most current prices and telephone or FAX numbers to call or web site or postal addresses to contact, please see Table 4.)

The primary goal set forth by the developers of the NRP is to ensure that every delivery is attended by persons periodically tested in the skills of neonatal resuscitation. All IHS health care professionals involved directly with delivery of newborn infants should complete the NRP course and keep their skills current.

The purpose of this chapter is to supplement the teaching materials of the NRP, emphasizing or clarifying certain points while adding practical details that may prove useful to Indian Health Service personnel. Specific objectives of the chapter include the following:

- Further delineate the principles of an effective neonatal resuscitation
- Contrast the ABCD's of neonatal versus adult resuscitation
- Review specific indications and some helpful tips for performing the various procedures involved in neonatal resuscitation.

Resuscitation of the depressed or asphyxiated newborn is not a simple skill but rather a series of procedures or individual skills arranged in proper sequence and graded to meet the patient's changing needs. Emphasis is placed on evaluation of the infant's condition before deciding what action to take next, and then re-evaluating the infant's response to that action before deciding what further action to take. This is called the *"evaluation/decision/action cycle."*

Please be aware that the Apgar score is no longer recommended for use in determining when to initiate resuscitative efforts or for making decisions regarding what actions to take during the course of a resuscitation. Rather, evaluation is primarily a matter of simultaneously scanning in your mind known risk factors involved with this baby, plus the results of your assessment of key clinical signs, namely *respirations*, *heart rate, color*, and (sometimes) *muscle tone*. On the basis of your evaluation you then decide what action to take next.

The major skills to be learned and applied in proper sequence in response to repeated evaluations of the infant's status include:

1. Various methods of upper and lower airway suctioning
2. Use of bag & mask apparatus to provide blow-by oxygen, manual positive pressure ventilation (PPV, and continuous positive airway pressure (Mask-CPAP)
3. Chest compressions (both the "thumb" and "two-finger" methods)
4. Endotracheal intubation to clear or secure the airway and to administer I.T. drugs
5. Umbilical venous catheter placement for *quick* I.V. access
6. Administration of appropriate drugs by prescribed route and in prescribed dosages

Organizational Considerations:

Personnel involved in neonatal resuscitation must be:

1. Adequately trained and skilled in the above-listed procedures
2. Actually present at the delivery, i.e., *not* just on call at home to come in *after* the delivery of a depressed infant
3. Capable of working as part of a team
4. Able to utilize the evaluation-decision-action cycle

Time is of the essence in newborn resuscitation. The longer an infant in need of resuscitation is apneic, hypoxic, acidotic or hypotensive, the more difficult the resuscitation becomes in terms of requiring more invasive procedures and achieving less prompt and favorable results (both acute and long-term). Thus, newborn resuscitation demands immediate and efficient support measures carried out by trained and competent personnel actually present at the moment of delivery.

Physiologic Considerations:

Resuscitation of the depressed or asphyxiated newborn infant is best conceived as lending support to an infant in the process of making the acute transition from intra- to extra-uterine life (see Table 2 in section on Perinatal Depression and Asphyxia in Chapter K). It involves knowledge of the factors behind the normal transition, assessment of where the infant is in that process, and awareness of what additional stressors have been imposed by prenatal difficulties and those encountered in the birth process. It then involves provision of graded degrees of support to facilitate the transition process and counteract the ill effects of prenatal or intrapartum problems that may lead to perinatal depression or actual asphyxia. Thus, all steps taken and procedures performed during neonatal resuscitation find a "physiologic rationale."

Although the distinction between "primary" and "secondary" apnea is useful in predicting ultimate outcome (see section on Diagnostic Considerations in Chapter K), one should treat all apnea at birth as secondary apnea and immediately initiate resuscitative efforts.

Gas exchange in the lungs (replacing the placenta once the baby is delivered) depends primarily on fetal lung fluid leaving the alveoli, gas entering with breathing or ventilation, and the "relaxing" of pulmonary arterioles to allow for greater pulmonary blood flow. How quickly fetal lung fluid is cleared from the lungs depends largely on the forcefulness of the first few breaths, whereas pulmonary perfusion depends mainly on the degree of lung expansion achieved and the oxygen tension and pH of the blood perfusing the lungs.

Basic Principles of Newborn Resuscitation:

Neonatal resuscitation should be a planned, team event. Principles of an effective neonatal resuscitation are as follows:

1. *Be prepared!*
   Anticipate the need for resuscitation (see Table 1.) and have the necessary skilled personnel, functional equipment, and appropriate medications instantly accessible. Table 2. below lists the minimal equipment necessary to support the team, and Table 3 lists the medications used, their indications, and their individual dosages.
2. *Keep it simple and familiar!*
   Only basic equipment familiar to all involved should be used in neonatal resuscitation. A simple anesthesia bag with attached manometer to display pressure and a port to receive 100% oxygen, or a self-inflating bag with oxygen reservoir is all that is needed for ventilation. This should be the same bag & mask set-up used in the Normal Nursery or Special Care Nursery, and one which everyone is accustomed to using. Only three drugs plus volume expanders are recommended for use in acute neonatal resuscitation, and each is to be offered in only one concentration in the delivery room.

3. *Keep it organized!*
   Action assignments should be made in advance if at all possible. The *first* (and most experienced) person should be assigned to handle the airway and ventilation, including suctioning of the upper and lower airways, assessing breath sounds, providing blow-by oxygen, Mask-CPAP or bag and mask ventilation, intubating, and carrying out manual ventilation through the endotracheal tube if necessary. The *second* person is assigned the circulation, including assessing heart rate, palpating for presence of peripheral pulses and adequacy of peripheral circulation, and performing chest compressions if necessary. The *third* person, if available, may be assigned the job of providing metabolic and drug support, including drawing-up medications, placing an umbilical venous catheter, and administering the drugs I.T. or I.V.
4. *Repeatedly assess the baby's response to your efforts!*
   Note the time of onset of the baby's spontaneous breathing or first gasp in relation to the time you instituted effective resuscitation. If the baby doesn't respond as well as expected to your resuscitative measures, look first for malfunctioning equipment, or a blocked airway, or a complication of a procedure already performed, such as incorrect placement of the ET tube or a tension pneumothorax. Also, consider the possibility of narcotic depression, and then "think" congenital anomalies such as diaphragmatic hernia or TE fistula, conditions that typically get worse when bag and mask ventilation is attempted (see section on Birth Defects in Chapter L).

Call early for help if needed, and call late (but call!) for a decision to halt further resuscitative efforts if any of the following conditions or circumstances exists:

- Anencephaly
- Trisomy 13 or 18
- Extreme prematurity (less than 23 weeks gestation) or extreme low birth weight (less than 500 grams)
- If no spontaneous heart rate has been detected after 15 minutes of complete resuscitative efforts

The ABCDs of Neonatal Resuscitation

The ABCDs of neonatal resuscitation are essentially the same as for pediatric or adult resuscitation, namely **Airway**, **Breathing, Circulation** and **Drugs**. However, the "specifics" of neonatal advanced life support (NALS) vary considerably from PALS and ALS, and warrant close scrutiny.

A. Establish a Clear and Effective Airway:

- Position the infant on the back or side, with the neck slightly extended in the "sniffing" position. A rolled blanket or towel placed under the shoulders may be useful if the baby has a large occiput due to molding, caput, or prematurity.
- Clear the airway by wiping the mouth and nose, or by suctioning…. preferably bulb suctioning….starting with the mouth and posterior pharynx and then moving on to the nose if necessary.
- If the baby is born through meconium-stained amniotic fluid, the delivering practitioner should suction the nose, mouth and posterior pharynx upon delivery of the head *("on the perineum"*), and before the baby's first breath.
- If the "mec-stained" baby is still "depressed" when placed on the resuscitation table, one should immediately intubate with a large endotracheal tube attached to a meconium aspirator (or use a #10 Fr DeLee trap) to clear the lower airway.
- Consider inserting an oral airway if any of the following rare conditions exist:
  1. Bilateral choanal atresia
  2. Pierre Robin syndrome
  3. Inability to ventilate a child without his mouth held open

B. Initiate and Maintain Adequate Breathing:

- If the patient is not breathing spontaneously, first apply tactile stimulation by rubbing the back along the spine or slapping or flicking the sole of the foot. But don't persist in doing this for more than a few seconds, since further stimulation rarely proves effective.
- If the infant remains apneic or is not showing adequate spontaneous respiratory effort to maintain a heart rate above 100/minute, employ positive-pressure ventilation with bag & mask set-up, and assess for adequate ventilation and oxygenation.

*Signs of adequate **ventilation** include:*

1. Good chest rise or rib expansion bilaterally.
2. Good breath sounds bilaterally.
3. Cessation of gasping respirations. It should be noted that gasping respirations indicate severe compromise and should not be confused with effective breathing.

*Evidence of adequate **oxygenation** includes:*

1. Rise in heart rate above 100/ minute
2. "Pinking-up" of the patient (or resolving of central cyanosis). Please note that the heart rate of an infant may remain low despite pinking-up if the infant is already severely acidotic. Pink skin color should encompass the trunk and proximal extremities. One should also evaluate the color of the tongue and nail beds in order to distinguish between "central" and "peripheral" cyanosis. If central cyanosis is present in an infant with spontaneous respirations and an adequate heart rate, give free-flow or "blow-by" oxygen.
   If you are unable to achieve adequate chest rise and breath sounds with bag and mask ventilation, intubate and manually ventilate through the ET tube.

C. Ensure Adequate Circulation:

- If the heart rate is below 60/minute, a second person is called to institute chest compressions in coordination with ongoing bag and mask ventilation. Ideally the chest is compressed three times for every bag ventilation, for a total of 90 compressions and 30 breaths per minute.
- Chest compressions may be provided using either the thumb (preferable) or two-finger technique, with pressure applied to the lower third of the sternum (below an imaginary line drawn between the nipples). Enough pressure is used to compress the chest to a depth equal to approximately one-third of its A-P diameter.
- Continue chest compression until spontaneous heart rate exceeds 60/minute (as palpated at the base of the cord). Bag and mask ventilation (at a more rapid rate of 40-60 breaths per minute) must be continued, however, until the pulse remains above 100 bpm and spontaneous ventilation is adequate.

D. Administer Appropriate Drugs in Safe but Effective Dosage

(See Table 3)

Fortunately, medications are rarely needed in neonatal resuscitation (< 1%), but when they are they can be life saving. Only three different medications plus volume expanders are presently recommended for use in the delivery room.

- Persistent bradycardia is treated with *Epinephrine* injected I.T. (Intratracheal) rapidly into the ET tube, or I.V. through an umbilical venous catheter (UVC) or peripheral intravenous line. **Intracardiac injection is not recommended for newborns!** The dose (0.1 - 0.3 mL/Kg of 1:10,000 solution) may be repeated several times if necessary.
- Remember that catecholamines such as epinephrine are generally ineffective in improving cardiac rate or contractility in the presence of a severe metabolic acidosis. Documented metabolic acidosis (by cord blood gas results) or suspected acidosis is treated with dilute (0.5 mEq/mL) *sodium bicarbonate*, 2 - 3 mEq/Kg per dose, given slowly I.V. through a UVC or peripheral intravenous line. The eventual goal is to raise serum bicarbonate ($HC0_3$) level to approx. 20 mEq/L or reduce base deficit (or negative base excess) to approximately minus 4.

- Suspect hypovolemia and give *volume expanders* if any one of the following is noted:
  1. History of bleeding from the maternal-fetal unit
  2. Pallor despite adequate oxygenation
  3. Mottled skin with delayed capillary refill time
  4. Faint pulses with tachycardia
- Hypovolemia is treated in the delivery room preferably with crystalloid volume expanders such as 10 mL/kg *Normal Saline* or *Ringer's Lactate* given by slow (over 10-20 min) IV push through a UVC. Less readily available and carrying a small risk of blood-product-borne infection are *human albumin* preparations and donor whole *blood* or packed RBCs. One gram/Kg (or 4 mL/Kg) of 25% salt-poor human albumin or 10 mL/Kg of 5 % human albumin (Albumisol®) may be given by even slower (over 30-60 min) IV push through a secured UVC or peripheral I.V. (often difficult to start in a "shocky" infant). O-negative blood, cross-matched with mother's blood (if available) is extremely helpful in cases of severe intrapartum hemorrhage.
- Inadequate depth of breathing may require naloxone (Narcan®) administration to overcome respiratory depression due to maternal narcotic administration within four hours of delivery.
- A fourth drug, Dopamine administered I.V. as a continuous infusion, may be needed after the initial resuscitation if perfusion remains poor, pulses are "thready," and evidence of hypotension or shock persists.

Summary of Contrasts between the ABCDs of Neonatal vs. Adult Resuscitation:

A. *In neonatal resuscitation, there is great need for selectivity and precise method of clearing the **Airway**, depending on the specific circumstances:*

- After delivery, the appropriate method of clearing the airway further (which assumes that the baby was previously suctioned on the perineum) will depend on the following:
  1) Presence of meconium
  2) Baby's level of activity
- If no meconium is present and secretions cannot be removed from the airway by simply wiping the nose and mouth with a towel, clear the airway with a bulb syringe (preferred), or with a suction catheter attached to wall suction (vacuum) with negative pressure set at approximately 100 mm Hg
- When meconium is observed in the amniotic fluid and the newly born infant demonstrates signs of "depression," then immediate and direct tracheal suctioning is recommended (whether or not the meconium is "thick" or "thin")

  SIGNS OF DEPRESSION include any or all of the following:
  1) Absent or inadequate respirations
  2) Heart rate <100 bpm
  3) Poor muscle tone
- Always suction the mouth before the nose! ("M" comes before "N")

B. *The rate and pattern of spontaneous and artificial **Breathing** for the newborn are quite different from those for the adult:*

- Faster respiratory rate (30-60/min)
- The fast respiratory rate in conjunction with an I/E ratio of 1:3 allows for only split-second inspiratory time (I-time) when bagging
- It is simply not true that smaller babies need less pressure! What they need is less volume, and thus one sharply squeezes (or better yet "twitches") with a smaller (1/2 liter) bag!

C. *The "transitional" **Circulation** of the newborn requires special consideration during resuscitation in order to 1) facilitate the transition from a "water-filled" to "air-filled" lung, 2) quickly go from a poorly-perfused (< 10% of right-sided fetal cardiac output went to the lungs) to a well-perfused (approaching 100% of cardiac output going to the lungs) pulmonary circuit, and 3) convert from an "in-parallel" flow pattern of the fetus to an "in-series" type circuit of the adult by closing the fetal (R -> L) shunts:* If the speed with which fetal lung fluid is cleared from the lungs depends on the forcefulness of the first few breaths, then prompt application of PPV in the depressed neonate is paramount for facilitating this first step in *transition.*Since pulmonary perfusion depends mainly on the degree of lung expansion and the oxygen tension and pH of the blood perfusing the lungs, then we need to support these processes when necessary by applying PPV and Mask-CPAP, using oxygen to do so and by blowing-off CO2, or (rarely) give bicarbonate (to raise pH).

- Closing the fetal shunts (Ductus arteriosus and Foramen ovale) is predominantly a matter of decreasing pulmonary vascular resistance (by lung expansion) and of increasing pulmonary blood flow (by the means described above).

D. *Certain commonly used **Drugs** in adult resuscitation, namely atropine and calcium, are actually <u>contraindicated</u> for use in depressed neonates:*Atropine does not increase cardiac output in the depressed neonate! Instead, its tachycardic effect masks the "tell-tale" bradycardia of asphyxia, a most-important sign in delivery-room assessment of the neonate.

- Calcium in the presence of perinatal depression or asphyxia can cause cardiac arrhythmias, including asystole!

Summary of Specific Indications for Procedures of Neonatal Resuscitation:

<u>Indications for Bag and Mask Ventilation:</u>

1) If baby is <u>not</u> breathing (i.e., is apneic) when first assessed and doesn't respond to drying and other tactile stimulation (but has a good heart rate and some muscle tone, so doesn't require immediate intubation)
2) If baby's heart rate is below 100 beats per minute (or less than 10 beats in 6 seconds)

<u>Indications for Endotracheal Intubation:</u>

(Please note that varying indications for endotracheal intubation can occur at several points during neonatal resuscitation. Also, the timing of endotracheal intubation often depends on the skill and experience of the operator.)

1) If born lifeless (Apgar O; pale, apneic and limp)
2) If unable to achieve adequate chest rise, breath sounds, or heart rate response (>>100 / min) with bag & mask ventilation
3) When prolonged manual ventilation is required (>> 5 minutes)
4) When direct tracheal suctioning is required (e.g., birth through meconium-stained amniotic fluid and the baby is "depressed" (i.e., <u>not</u> vigorous)
5) When congenital diaphragmatic hernia is suspected;

   SIGNS SUGGESTIVE OF CONGENITAL DIAPHRAGMATIC HERNIA:
   - "Scaphoid" abdomen
   - "Decreasing Apgar scores"
   - Heart sounds displaced to the right (since majority of CDH cases are on the left)
   - Decreased breath sounds bilaterally (but especially on the left)

<u>Indications for Chest Compressions:</u>

1) If no heart beat present at birth (Apgar 0)
2) If heart rate is below 60/min (or < 6 beats in 6 seconds)

*Indications for **UVC Placement:***

1. If heart rate remains < 60/min despite adequate manual ventilation, external cardiac massage, and intratracheal administration of epinephrine
2. If infant suspected of being in hypovolemic shock or significant metabolic acidosis
3. If infant grossly hydropic (enabling measurement of CVP and management for circulating volume reduction or replacement, as well as IV drug administration and Lab blood draws)

*Indications for **Drugs**:*

EPINEPHRINE (may be given IT or IV)

1. By persistent asystole (heart rate = zero)
2. When heart rate < 60/min after 30 seconds of adequate ventilation and chest compression

VOLUME EXPANDERS (Normal Saline, Ringer's Lactate, 5% Albumin, PRBCs, or Blood)

1. If persistent bradycardia after adequate ventilation, chest compression, and administration of epinephrine
2. When pallor & weak pulses persist despite good heart beat and oxygenation
3. When evidence of acute bleeding with signs of hypovolemia

CLINICAL SIGNS OF HYPOVOLEMIA:

- Delayed onset of breathing at birth
- Pale lips, tongue and distal extremities
- Pale, mottled or dusky skin color
- Delayed capillary refill time (> 4 sec)
- Tachycardia with weak peripheral pulses

SODIUM BICARBONATE (given only IV)

1) When presumed or documented (via cord blood gases) metabolic acidosis exists

NALOXONE (Narcan®)

2) Depressed respirations AND a history of maternal narcotic administration within 4 hours of birth

Notes on Specific Procedures Used in Neonatal Resuscitation

Although practice is the best teacher in mastering the procedures so crucial in timely and effective resuscitation of the depressed or asphyxiated newborn, a few "tips" can be offered that will perhaps aid in efficient performance of these life-saving, emergency procedures. Animal or manikin models may prove the best means to gain the practice and confidence needed to master these procedures.

1. Bagging

- Positioning: Support the chin firmly by lifting it forward and upward, curling your 4th and 5th fingers around the jaw. Your first finger and thumb tip should encircle the stem of the mask, whereas your middle finger and thumb base should be at the edge of the mask to firmly secure the mask to the face, covering the chin, mouth and nose, and making an air-tight seal. Be sure the mask does not compress the nose or eyes, but rather incorporates both the nose and mouth comfortably. Remember, most babies quickly become obligatory nose breathers.
- Timing: Bag at approximately 40 times a minute saying to yourself "Squeeze, two, three. . . Squeeze, two, three," etc. Note that the "squeeze" of active inspiration when done properly takes only one-third of the total breathing-cycle time (or one-half second of the total one & one-half seconds available for each breath). This leaves two-thirds of the cycle time for passive exhalation, known to take longer since it depends on the passive recoil of the lungs and chest cage. If insufficient time is provided for exhalation, air trapping will occur, and you run the risk of producing a tension pneumothorax.

- Pressure: Use the least amount of pressure (read from an in-line manometer) necessary to expand the lungs and adequately move the chest. However, this may initially be well over 35 cm H_2O peak inspiratory pressure. Once the lungs are more fully inflated, one can usually back off the higher pressures and achieve adequate expansion and ventilation at lesser pressures, assuming that lung compliance is improving. It is *not* my experience that very low birth weight infants requiring assisted ventilation at birth need less positive pressure for expansion than the larger term babies. What they need is much less volume!

2. Endotracheal intubation

- Positioning the baby: Place the head of the baby on a pad (rather than placing a roll under the neck) to bring the head in a "sniffing" or neutral (not flexed, not extended) position.
- Inserting the laryngoscope blade: Lean over the baby (rather than stoop down level with the baby's body). Pass the laryngoscope blade straight down (rather than horizontally) into the throat with the handle running horizontal (rather than vertical).
- Visualizing the cords: Thrust outward or away from the skull with the instrument (rather than cranking back on the handle), to move the tongue forward and expose the anterior larynx, epiglottis and cords. At the same time, pull back (towards the chin) with your little finger to keep the glottis in view.
- Inserting the ET tube: Drop the tip of the ET tube almost straight down through the open cords, visualizing the vocal cord guide or marker rings on the tube as they pass through the cords. This allows estimation of how far in the tube has been inserted and helps to avoid right-mainstem bronchus intubation.

- SIZE OF ENDOTRACHEAL TUBE USED FOR INTUBATION:

Birth Weight	Gestational Age	Tube Size
< 1000 gm	- 28 wk	2 . 5 mm
1000-2000	29-34	3 . 0
2000-3500	35-38	3 . 5
> 3500	Term or Postterm	4 . 0

- POSITION (DEPTH OF INSERTION) OF TUBE:

Approximate Birth Weight	Tube Tip Beyond the Cords	Distance, Lip to Tip
7 cm	1000 gm	1 . 5 cm
8	2000	2 . 0
9	3000	2 . 5
10	4000	3 . 0

3. Chest compressions

(Please note that the term “chest compressions” is now used instead of “external cardiac massage.” That is because chest compression is a more accurate description of the procedure and what actually is being accomplished, namely more than just external squeezing of the heart muscle. Besides compressing the heart between the sternum and vertebral column of the chest cage, you are also increasing intrathoracic pressure during the downthrust of compressing the chest cage which aids in forcing blood out the aorta and pulmonary artery and into the pulmonary and systemic circulations. Then on release, intrathoracic and right-atrial pressures decrease, aiding diastolic and pulmonary circuit filling [and therefore stroke volume and pulmonary blood flow respectively], plus entry of air into the lungs during concomitant, “coordinated” bag and mask ventilation.)

- Hand(s) and Finger Placement:

  Thumb Method: Approaching the baby from his or her feet, place both hands around the infant’s chest encircling the torso with fingertips along the spine (posterior), and both thumbs on the lower one-third of the sternum (anterior). The thumbs may be placed side by side, or over one another, depending on the size of your hands and the baby’s chest.

  Two-finger Method: Position the index and middle fingers of your dominant hand on the lower sternum just below the nipple line.
- Compression Depth: This should be approximately one-third of the anterior-posterior diameter of the chest
- Timing and Coordination: In conjunction with the first person bagging approximately 30 breaths per minute, the second person compresses the chest about 90 times per minute. Thus, there should be approximately 120 “events” per minute (with each 4-event cycle taking 2 seconds). The “cadence” is: *One-and-Two-and-Three-and-Breathe-and-One-and-Two-and-Three-and-Breathe…., etc.*

4. Umbilical Venous Catheter (UVC) Placement

- In the delivery room where speed is critical, catheterization of the umbilical vein is preferable for quick administration of drugs and volume expanders.
- Throw a quick tie of umbilical tape around the base of the cord to control eventual bleeding.
- Bend the clamped cord downwards towards the pubis of the baby and make just a partial cut through the dorsal surface of the cord over the 1:00 o’clock position slightly up on the cord away from the skin. Cut down only deep enough to sever the umbilical vein vessel.
- Place the tip of the umbilical catheter in the vicinity of the cut vessel and push in the direction of the right shoulder. No dilation of the vessel is ever required. The blunt tip of the umbilical catheter will always fall into the lumen of the umbilical vein in contrast to the arteries where it tends to dissect down along the vascular sheath if not inserted precisely into the dilated vessel lumen.
- Advance the catheter as far as is needed to get good blood return; this is usually before you reach the first black mark on the catheter or before a depth of 5 cm. Fixate the catheter in this position.
- Only dilute solutions should be infused through UVCs.

Heat loss or hypothermia must be avoided during neonatal resuscitation since it results in reduced peripheral circulation, acidosis and increased oxygen consumption, all stressors that impede the transitional process and recovery.

Post-Resuscitation Care:

Any baby who has required resuscitation (beyond provision of warmth via radiant-heat warmer, wiping or bulb-suctioning the upper airway clear, and drying off to conserve heat and encourage crying or deep breathing) is at risk for later deterioration and returning to the fetal pattern of circulation, i.e., having at least a difficult *transition*.

There are essentially three levels of post-resuscitation care:

1. ***Routine Care***, for babies with no real risk factors and who deliver through clear amniotic fluid:
   - They may stay with their mother after assignment of a 5-minute Apgar score of eight or above.
   - Ongoing periodic observation of vital signs, activity level, and interest in mom and surroundings is in order.
2. ***Supportive Care***, for babies who have prenatal or intrapartum risk factors such as meconium staining, depressed breathing, or reduced activity level or remained centrally cyanotic, and thus required some degree of resuscitation at birth:
   - These babies should remain under a radiant warmer and very close observation until proven to have successfully made the transition to extra-uterine life (see section on Neonatal Assessment in Chapter L).
   - Electronic monitoring of HR, Respirations, and Oxygen Saturation may well be indicated.
   - The family or referring practitioner who will provide follow-up or "Well-Baby Care" must be made aware of the risk factors and resuscitation procedures performed.
3. ***Ongoing Care***, for babies who required PPV or more extensive resuscitation:
   - These babies are at significantly high-risk for developing problems in transition and/or post-depression/post asphyxia complications (see Chapter K).
   - Ongoing evaluation and monitoring should take place in a Level II Special Care Nursery or Level III NICU.

REFERENCES

See Table 4 for full listing of Neonatal Resuscitation Program (NRP) materials:

Clark JM, Brown ZA, Jung AL. Resuscitation equipment board for nurseries and delivery rooms. JAMA 1976;236:2427-8. (Level III)

Recommendations on resuscitation of babies at birth. International Liaison Committee on Resuscitation. Resuscitation 1998;37:103-10. (Level III)

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Niermeyer S, Kattwinkel J, Van Reepmts P, Nadkarni V, Phillips B, Zideman D, et al. International Guidelines for Neonatal Resuscitation: An Excerpt from the Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care: International Consensus on Science. Contributors and Reviews for the Neonatal Resuscitation Guidelines. Pediatrics 2000;106(3):E29. (Level III)

Table 1.

High-Risk Factors Commonly Associated with Need for Neonatal Resuscitation

Antepartum High-Risk Factors:

Maternal diabetes
Pregnancy-induced hypertension
Chronic hypertension
Anemia or isoimmunization
Previous fetal or neonatal death
Bleeding in second or third trimester
Maternal infection
Maternal cardiac, renal, pulmonary, thyroid, or neurological disease
Polyhydramnios
Oligohydramnios
Premature rupture of membranes
Post-term gestation
Multiple gestation
Size-dates discrepancy
Drug therapy, e.g.:
- Lithium carbonate
- Magnesium
- Adrenergic-blockers

Maternal substance abuse
Fetal malformation
Diminished fetal activity
No prenatal care
Age < 16 or > 35 years

Intrapartum High-Risk Factors:

Emergency cesarean section
Forceps or vacuum-assisted delivery
Breech or other abnormal presentation
Premature labor
Precipitous labor
Chorioamnionitis
Prolonged rupture of membranes (> 18 hours before delivery)
Prolonged labor (> 24 hours)
Prolonged second stage of labor (> 2 hours)
Fetal bradycardia
Non-reassuring FHT patterns
Use of general anesthesia
Uterine tetany
Narcotics administered to mother within 4 hours of delivery
Meconium-stained amniotic fluid
Prolapsed cord
Abruptio placentae
Placenta Previa

Table 2.

Equipment and Supplies for Neonatal Resuscitation

General Equipment:

- Large clock with sweep second hand
- Radiant heat table or warmer with manual-controlled temperature, adjustable tilt, and side boards
- Infant stethoscope
- Wall-mounted equipment board or crash-cart or dedicated tackle box for supplies and drugs
- Gloves to protect personnel
- Dry, clean, and preferably pre-warmed linen including towels and small blankets

Suction Equipment:

- Bulb syringe
- Meconium aspirator
- Suction catheters, #5 or #6, #8, and #10 or #12Fr., and a #10Fr. DeLee trap with connector tubing to wall suction apparatus set at 80-100 (neg) mm Hg
- #8 Fr. feeding tube and 20-mL syringe

Bag-and-Mask Equipment:

- Neonatal resuscitation bag with flow-control valve (to set Mask-CPAP level), pressure-release or pop-off valve (to set maximal PIP), and pressure manometer (to display PIP) and CPAP being delivered
- Face masks, newborn and premature sizes, with cushioned rims
- Oxygen source with flow meter, and tubing to connect with bag & mask setup; system should be capable of delivering 7 – 10 L/min 90 – 100% oxygen to the baby's lungs

Intubation Equipment:

- Laryngoscope with Miller blades (#0 for premature and AGA term infants, and #1 for LGA-term or post-term neonates)
- Extra bulbs and batteries for laryngoscope
- Endotracheal (ET) tubes (not Cole type), sizes 2.5, 3.0, 3.5 and 4.0-mm internal diameter (ID)
- Malleable stylet for ET tube (optional)
- Scissors
- Tape (both ½ inch white adhesive, and ¾ inch Elastoplast®) or securing device for fixation of the ET tube
- Alcohol sponges
- CO2 detector (optional)
- Laryngeal mask airway or LMA (optional, and for use only by appropriately trained providers)

Umbilical Vein Catheter Placement Equipment:

- Packet of umbilical tape
- Povidone-iodine solution
- Umbilical catheter with single end-hole, #5Fr.
- 3-way stopcock
- #11 scalpel blade (blade holder optional)
- Needles, sizes 25, 21 and 18
- Two heparinized tuberculin syringes (for umbilical blood gas sampling), three 10 mL syringes (for Lab blood draw and for flushing catheter) and 3 each 1, 3, 5 and 20 mL syringes for drug administration
- 10 mL bottle of NS for flush solution
- Sterile gloves for operator

Table 3. Drugs Used in Newborn Resuscitation

Medication	Concentration to Administer	Preparation	Dosage/ Results	Infant Weight/Total Dose	Rate of Administration/ Precautions to Take	Indications for Use
Epinephrine	1:10,000	1mL Vial	0.1 – 0.3 ML/kg I.V. or I.T.	Weight Total mL's 1kg 0.1-0.3 mL 2kg 0.2-0.6 mL 3kg 0.3-0.9 mL 4kg 0.4 1.2 mL	Give rapidly	Heart rate <80 after 30 seconds adequate ventilation AND chest compressions, OR heart rate is zero
Volume Expanders	Whole Blood 5% Albumin Normal Saline Ringer's Lactate	50 mL Vial	10mL/kg I.V.	Weight Total mL's 1kg 10 mL 2kg 20 mL 3kg 30 mL 4kg 40 mL	Give over 5-10 min	Evidence of acute bleeding with signs of hypovolemia
Sodium Bicarbonate	0.5 mEq/mL (4.2% solution)	20 mL or two 10-mL Prefilled syringes	2mEq/kg I.V.	Weight Total Dose Total mL's 1kg 2mEq 4mL 2kg 4mEq 8mL 3kg 6mEq 12mL 4kg 8mEq 16mL	Give slowly, over at least 2min. Give only if Infant being effectively ventilated.	Documented metabolic acidosis
Naloxone	0.4 mg/mL --- 1.0 mg/mL	1 mL Vial --- 1 mL Vial	0.25 mL/kg I.V., I.M., S.Q., or I.T. --- 0.1 mL/kg I.V., I.M., S.Q., or I.T.	Weight Total mL's 1kg 0.25 mL 2kg 0.50 mL 3kg 0.75 mL 4kg 1.00 mL --- 1kg 0.1 mL 2kg 0.2 mL 3kg 0.3 mL 4kg 0.4 mL	Give rapidly.	Severe respiratory depression AND history of maternal Narcotic Administration within past 4 hours
Dopamine	weight desired dose 6X (kg) X (mcg/kg/min) desired fluid (mL/hr) EQUALS mg of dopamine per 100 mL of solution		begin at 5 mcg/kg/min (may increase to 20mcg/kg/min if necessary) I.V.	Weight Total mcg/min 1kg 5-20 mcg/min 2kg 10-40 mcg/min 3kg 15-60 mcg/min 4kg 20-80 mcg/min	Give as continuous Infusion using an infustion pump. Monitor IIR and BP closely. Seek consultation	After Initial resuscitation, continued poor perfusion, thready pulses, evidence of shock.

Table 4.

NRP Teaching Materials

ITEM DESCRIPTION	ITEM #	PRICE	
Textbook of Neonatal Resuscitation, 4th ed with CD-ROM	NRP101	$39.95	Quantity
Discounts 10 – 49	NRP101	38.95	Quantity
Discounts 50 – 99	NRP101	37.95	Quantity
Discounts 100 or more	NRP101	36.95	
NRP Instructor Manual (3-ring binder)	NRP102	49.95	
NRP Written Evaluation Packet (Instructor NRP ID# required)	NRP103	24.95	
NRP Video (VHS)	NRP104	179.95	
NRP Video (PAL)	NRP112	199.95	
NRP Slide Presentation Kit (160 Slides)	NRP105	159.95	
NRP Slide Presentation Kit on CD-ROM	NRP106	129.95	
NRP Reference Chart (22” x 17” wall chart)	NRP107	19.95	
NRP Code Cart Card (8” x 11” single purchase)	NRP110	5.95	
NRP Code Cart Card (Pack of five)	NRP113	24.95	
NRP Pocket Cards (4” x 16” single purchase)	NRP111	3.50	
NRP Pocket Cards (Pack of ten)	NRP114	24.95	
NRP Instructor Pin	NRP108	5.00	
NRP Provider Pin (Pack of 25)	NRP109	49.95	

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