Title: Newborn Examination: Training Manual (English)

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Newborn Examination

Training Manual

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and Sadie Rae Litner, for her many appearances in the pictures.

Table of Contents

Guidelines for choosing the trainer

- The training should ideally be performed by a pediatrician who is well versed in conducting newborn examinations.

Guidelines for the trainers

- You should read the manual thoroughly. Please review the organization of the slides prior to the training.
- Both Julie Gutman (fff2@cdc.gov) and Laura Sangaré (lsangare@u.washington.edu) are available via email or conference call to answer any questions regarding the materials or how to conduct the training.
- The emphasis for training midwives and nurses should be on identifying those infants who need further evaluation by the study clinician or examiner. The midwives/nurses should not get overwhelmed about being able to properly name the birth defects. They should be encouraged to send any infant in which there is a question of a birth defect for further evaluation. The message should be to photograph any suspected anomalies and send all suspect cases for further evaluation.
- The training should be highly interactive with the participants being encouraged to ask questions and discuss any possible issues. The trainer can pose questions to the group such as, "What malformations have you come across in your work with delivering babies?"
- You should have a sense of what level of experience the participants have in conducting newborn screening exams before they begin the training. This can help guide the training to the level of the participants, and identify what items may require more or less time.
- The training is an opportunity to practice filling out the newborn evaluation form, with specific emphasis on those infants in which the midwife/nurse is uncertain if a condition exists. You should use the photos in the presentation as an opportunity for the midwife/nurse to identify where on the form these malformations would be indicated, and what words they would use to describe them.
- You should orient the trainees to the manual, how to use it as a reference, and the importance of having each trainee read through the manual in its entirety.
- If you are at a site which has a limited number of newborns we offer the following suggestions:
    1) Conduct the practicum on newborn screening and Ballard exam in another location, such as a large hospital where there will be a sufficient number of newborns for the number of participants in the training; or
    2) Mobilize the community to have the appropriate number of women with their newborns come to the clinic to have enough newborns for the number of participants in the training.

Sample agenda

PowerPoint presentation on conducting a newborn examination and determining the Ballard score– 2 – 2.5 hours (assuming discussion throughout the presentation)

Demonstration of a newborn exam – 15 minutes

Practicum – students practicing the newborn exam – 1.5 to 2 hours

- You should monitor how the students are handling the newborns. Each trainee should wash his or her hands prior to starting to handle each baby, as well as after completing the examination. Emphasize the importance of washing the hands between examinations, to prevent the spread of an infection from one baby to another.
- Each infant may be examined by more than one trainee, but should not be away from the mother or out of the nursery for more than 2 hours. If the infant becomes fussy, the student should finish the exam, and then the baby should be returned to his/her mother or to the nursery.
- If there are enough infants, trainees should be paired so that one watches while the other performs the examination, and then they should switch. If there are not sufficient babies, the groups may be bigger, but ideally no more than 4 trainees per infant.
- While 1 student is examining the newborn, the others should watch and be encouraged to ask questions and have a discussion about the process or the findings.
- Depending on the number of participants, the practicum portion could take several hours for each person to have a chance to examine the newborn.
- All participants will need to be observed by the trainer or an experienced examiner at least 10 times and have this recorded in the training log. These may be done on the day of training.
- Each trainee will need to observe a skilled examiner at least 3 times. Ideally, the trainer will demonstrate the exam once, allow the trainees to practice several times while being observed, and then demonstrate the exam again and allow for additional practice thereafter.
- We recommend having each student fill out the newborn examination form for at least one of the babies he or she examines.

Demonstration of conducting the Ballard score exam – 15 minutes

Practicum – students practicing the Ballard score exam – 1.5 to 2 hours

- We recommend having each student fill out a Ballard score sheet for each baby he or she examines.

Review of material – 1 hour

- This is a good opportunity to discuss the experience of conducting the exam, filling out the form, and to address any remaining questions or to discuss items which were noted to be problematic during the practicum.
- The trainer can utilize the photos in the slides to test the knowledge of the participants, by asking, for example, “Where would you record this condition, what words would you use to describe it, etc.”

I. INTRODUCTION

A study is being conducted at this clinic to better understand certain issues regarding malaria during pregnancy. Some of these issues involve understanding which drugs are best to use to treat malaria during pregnancy and looking at the safety of these drugs when used at different times during pregnancy.

Malaria occurs frequently in this community. During pregnancy, a woman's immune system is weakened, making her more susceptible to malaria infection, than women who are not pregnant. Malaria in pregnant women can cause several complications that are dangerous to the mother and her unborn child, including severe maternal anemia, hemorrhage, maternal death, miscarriage, stillbirth, and low birth weight of the newborn.

Newborn examination

As part of this project, you will be conducting a newborn examination. You will need to complete an examination on all babies (both live births and stillbirths) born to women enrolled in the study. A newborn examination has many purposes including:

- It allows us to quickly identify certain problems the baby may have been born with, and therefore provide each baby with the best care available; and
- It allows us to document the occurrence of congenital malformations, or birth defects, in each country, which can help us to understand the safety of medications given during pregnancy.

Congenital malformations

A congenital malformation, otherwise known as a "birth defect," encompasses a wide variety of conditions and is most simply defined as a defect which is present at birth. Birth defects may be easily seen, such as a cleft lip or cleft palate, or may affect internal organs and be more difficult to detect without sophisticated testing equipment, such as with certain heart defects. Birth defects can be cosmetic only, such as a dark birthmark on the face, or they can be life threatening such as a baby born with their intestines on the outside of the body. Our work will focus on identifying only those birth defects that can be seen when looking at the external anatomy of the newborn.

In industrialized countries such as the United States and Europe, approximately 2% of all babies born have a major malformation which is present at birth.[1-5] This is known as the background rate, which is a measure of how frequently birth defects are known to occur within a country. In industrialized countries, all babies are examined shortly after birth and their results are recorded, providing us with a count of the number of babies that are born abnormally. In most developing countries, we do not know how frequently babies are born with defects because newborn examinations either do not occur routinely, or if they do occur, the results are not recorded anywhere. Therefore, we do not know if birth defects are more or less common in developing countries than in industrialized countries.

There are several causes of birth defects,[1,6] most frequently:

- Genetic defects such as Down syndrome account for 10-15% of all birth defects
- Teratogens account for 7-10% of all birth defects
    - A teratogen is any agent that interferes with normal embryonic development such as alcohol, medications such as thalidomide, or infectious diseases like rubella.
- Multi-factorial, ie. due to the interaction of several factors, account for 30-35%

Up to 50% of birth defects still have an unknown cause.

For the purposes of this project, it is not important to be able to correctly name the different types of malformations. Rather, it is most important to be able to determine if a malformation is present. It is your job to identify babies with abnormalities. Confirming the abnormality and applying the correct name to the birth defect can be done later by a trained physician, or the official study examiner assigned to your clinic. If you are unsure if a baby has a malformation, that's okay. It is best to send that baby for further examination by the official study examiner in your clinic and let them decide if the baby is normal or not. Please take a picture of any possible abnormalities, so that they can be evaluated by the safety oversight group. Make sure that you include the baby's study ID number on the picture, so we will know which baby the picture belongs to.

Purpose of the newborn examination

The newborn examination can help us to determine if medicines taken by a pregnant woman are safe for her unborn baby. How can we determine if a drug is safe for use during pregnancy? Before new drugs are released, they go through a series of clinical trial phases. The last phase is testing in humans. However, pregnant women are excluded from most clinical trials in an effort to protect the unborn babies from unknown effects of the drug. When pregnant women are included, clinical trials are often not large enough to detect certain problems that occur very rarely, such as birth defects. In order to know if pregnant women who take a certain drug are more likely to have a baby with a birth defect than pregnant women who did not use that drug, we first have to know the baseline frequency of birth defects in that population or country. This research is important because we will be able to establish both background rates for birth defects (which are currently unknown in your country) and the rate of birth defects among babies being born to women given antimalarials in pregnancy. We will then be able to compare these background rates to the rates of birth defects observed among pregnant women using different drugs to understand if women taking the drugs have a higher rate of birth defects.

Currently, the limited data on use of antimalarials for the treatment of malaria during pregnancy suggests that most of them are safe for the unborn baby when used during the later part of pregnancy (in the 2nd and 3rd trimesters). However, we still need to improve the evidence by documenting both the number of normal babies born and the number of babies born with malformations among women who used antimalarial drugs during pregnancy. Women need to know that the drugs they are being offered are safe for their unborn baby. This research will help doctors and women make informed decisions about using drugs to treat malaria during pregnancy.

Importance of the examiner
The success of the project depends on the quality of your work. Your work conducting and recording these newborn screening exams will help us understand the safety of antimalarials used during pregnancy. Your careful observations will allow us to correctly count the number of birth defects, an important number which is currently unknown in your community.

Every baby needs an examination
Why does every baby need an exam? Because if you don't look for an abnormality, you may not see it.

Many obvious defects are often missed simply because nobody looked carefully at all parts of the newborn. For example, a defect such as an imperforate (closed) anus is life threatening and might otherwise go unnoticed if not specifically checked.

Fortunately, because most of the babies are born without malformations, the newborn exam is fast and easy. All babies must have the exam completed and documented on the correct form, even if they appear normal. Filling in all of the boxes will provide the appropriate evidence that these babies were born normally. It is critical to the project that all boxes are filled in and all babies be examined the same way by everyone.

Even among babies born without a birth defect, the newborn examination can also help us determine if there is a problem with the baby such as one caused from infection, poor feeding, respiratory problems, or other abnormalities. The newborn examination provides the earliest possible detection of abnormalities or other serious problems. The examination also establishes a baseline for subsequent examinations. For example, is a certain condition or feature getting better or worse?

- **When to conduct the newborn examination**

For babies born in the clinic, it is best to conduct the exam before the baby is sent home. For babies born at home, an effort should be made to complete a newborn exam within the first week of life. If an exam is not done within the first week of life, the baby should have a complete exam at their first visit. In all circumstances, the timing of the examination and age of the infant should be recorded on the appropriate form.

- **Length of the exam:**

A well skilled examiner can complete a basic examination within 5-10 minutes. However, when starting out, the exam may take a little longer as you get used to the order of the exam, filling in the forms, and all of the exam components.

- **Where to conduct the newborn examination**

The exam is most quickly and easily performed on an exam table. You should examine all exposed body parts first with the infant's clothing on, then remove all the clothing and thoroughly examine the rest of the body.

Tell the mother that you will be examining the baby and take the baby to the examination area. If the mother wishes, she may watch you during the exam.

Before starting the exam, always wash your hands with soap. Make sure to wash your hands again when you complete the exam, to prevent spreading diseases from one baby to another. Begin the exam when the baby is calm, this will help to take accurate measurements.

You will need a few materials in order to complete the exam:

- Tape Measure
- Digital Scale
- Examination Form
- IF available, stethoscope for auscultation (listening) to the heart and lungs.

Remember, babies cannot regulate their own body temperature and can quickly become too cold. After the examination is complete, remember to properly wrap the baby before returning them to their mother.

Newborn examination sheet

Some of the measurements you will take during the exam will be recorded on the "Newborn examination sheet", including:

- Date and time of examination
- Weight (grams)
- Head Circumference (HC) (cm)
- Length (cm)

II. TRAINING

Prior to performing newborn examinations alone, all staff should witness at least 3 examinations performed by a trained examiner, and then should be observed doing 10 examinations and checked off to make sure that they have mastered the examination. All staff should be re-checked after one month to make sure they are doing the exam correctly.

III. COMPLETING THE NEWBORN EXAMINATION

The exam will cover the following:

The order of the exam:

1. Record date and time of exam
2. General assessment and measurements
3. Skull
4. Face
5. Mouth & palate
6. Nose
7. Ear
8. Eyes
9. Chest
10. Abdomen
11. Arms
12. Hands
13. Legs
14. Feet
15. Genitals
16. Anus
17. Spine
18. Skin

Having a routine order of examination makes it less likely that you will forget any parts of the examination, however, your routine should be somewhat flexible. If the infant is quiet and relaxed when first approached, the assessment of respiratory rate and examination of the abdomen should be done before the baby is disturbed.

Observation

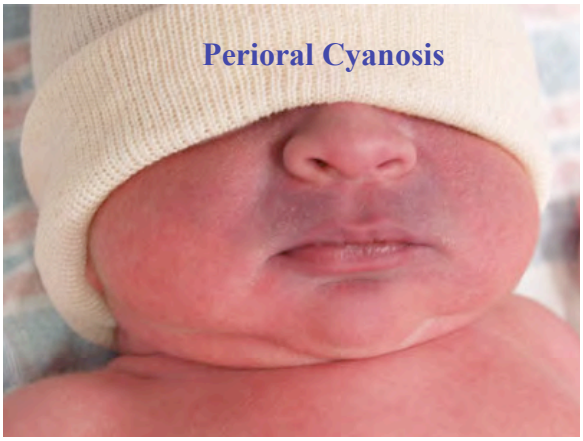
Before starting the exam take a minute to observe the baby. Ask yourself the following questions:

- What is the baby's color?
- In general does the baby look ill or well?
- Is the baby active?
- Is the cry normal?
- Are there any obvious malformations?
- Is the baby funny-looking, such as with a genetic syndrome like Down Syndrome?

Color

Notice the color of the newborn. Is he/she:

- Normal
- Pale
- Cyanotic (bluish)
    - Central cyanosis is a blue color to the trunk and is not normal. This indicates a problem with either the baby's heart or lungs. If you see this, please ask a doctor to see the baby!
    - Perioral cyanosis is bluish discoloration around the mouth. This is also not normal and indicates a problem with the baby's heart or lungs. If you see this, please ask a doctor to see the baby!
    - Acrocyanosis is a bluish discoloration of the hands and feet. It is commonly seen in newborns and is due to poor circulation to the extremities, often due to being cold. It does not indicate a serious problem.
- Jaundiced (yellow)
    - Jaundice is a yellow discoloration of the skin due to excess of bilirubin, which is formed by the break-down of haemoglobin from red blood cells. It is very common in newborns, and generally resolves in a few days. Sometimes it may require treatment with a special light.
    - Jaundice may be difficult to see in dark skinned babies. You can look at the white part of the eyes, or press on the nose or chin and release your finger to more easily see the yellow discoloration of the skin.



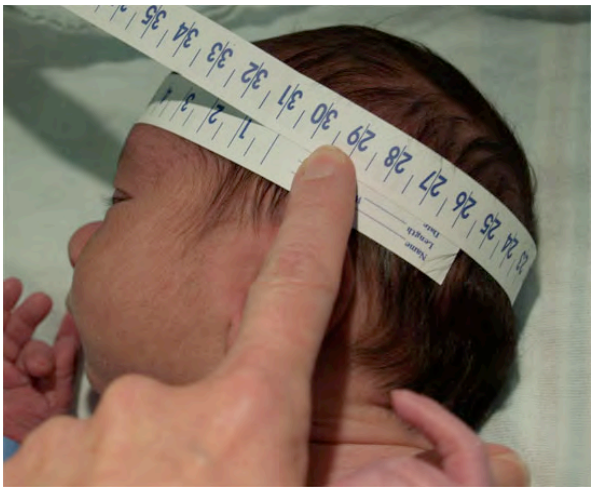
Measurements

Respiratory rate

- Normal range of a newborn is 40-60 breaths per minutes.
- Count the respirations for a full 60 seconds by watching the rise and fall of the chest. This should be done with the infant's chest exposed.
    - Counting respirations for 15 seconds and multiplying by 4 provides an inaccurate measurement in newborns. Make sure to count for the entire 60 second cycle.
- Take the respiratory rate when the infant is quiet. Remember to record the value on the appropriate form.

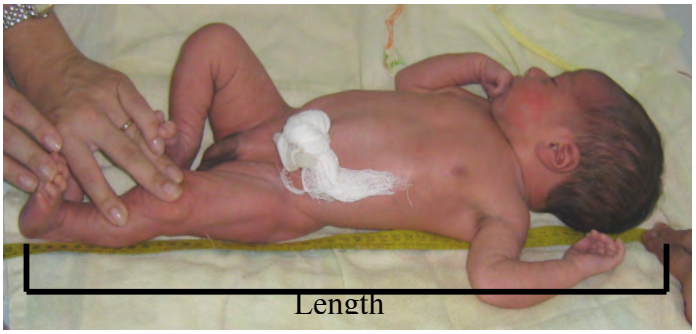
Head circumference

- Measure the head circumference in centimeters by placing the tape measure around the widest part of the head. This should be above the eyebrows and ears.



Length

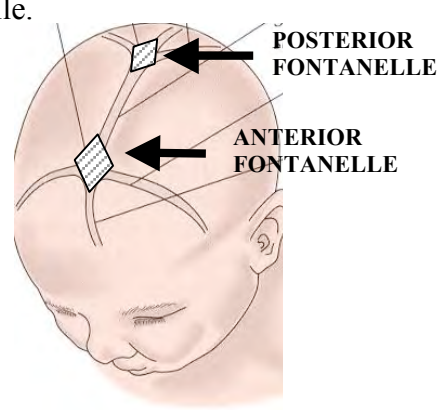
- Measure the head-to-heel length in centimeters while the baby is fully extended. This can be difficult depending on how active the baby is. This is best done using a UNICEF measuring board, which has a base at the bottom. The baby's head is placed at the board (at 0 cm), and the baby's legs are pulled straight. The length is the distance between the top of the head and the bottom of the feet,
- Another method for measuring the length is to make a mark on the sheet at the top of the baby's head and then without moving the body, stretch the legs straight and make a mark at the bottom of the feet. The distance between the 2 marks can then be measured once the baby is moved. You must make sure that the tape measure or measuring stick is not held at an angle, which will result in an incorrectly long measurement.



Head and skull bones

Fontanelle

The soft spot on the top of the baby's head is called the fontanelle. There is both an anterior and posterior fontanelle. The anterior fontanelle is in the front, and is larger and more obvious than the posterior fontanelle.



The anterior fontanelle can be:

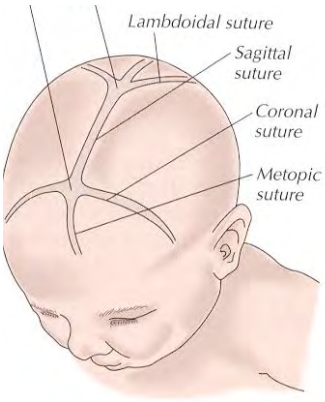
- Normal
- Raised or bulging- suggests infection
- Depressed or sunken- suggests dehydration
  - If you think the anterior fontanelle is NOT normal, notify a clinician.

Sunken fontanelle

Bulging fontanelle

Skull bones and Sutures

The top of the head is made of 8 different bones. While the baby is in the womb, these bones remain open (unfused) which allows the baby's head to compress when passing through the mother's pelvis. As the child ages, these bones grow together. The lines where the bones come together are called "sutures."



When examining the skull bones and suture lines, you should be able to feel the large soft spot in the middle (anterior fontanelle) and a smaller soft spot further back on the head (posterior fontanelle). It is normal to feel a line where the bone is open between these two soft spots, as well as other ridges where the bones are open to allow the baby to pass through the birth canal. Sometimes due to the pressure exerted on the head during the birth process, one bone will slightly overlap the other, and you will feel a step. This is normal and will go away in a few days.

Sometimes, these bones can grow together too early which can result in an abnormal shape of the head. This is called craniosynostosis. If you suspect craniosynostosis, this should be noted on the form. Or, if you observe the baby to have an abnormally shaped head this should be noted on the form.

Molding and Caput

Molding means the head becomes misshapen by the pressure in the birth canal. When the mother is in labor (especially if it is a long labor) the baby's head may undergo molding or may develop swelling. Swelling of the scalp due to the pressure in the birth canal may also occur, and is called "Caput". Both of these resolve without treatment and do not need to be recorded.

Normal molding

These two photos are examples of normal molding of the head after passing through the birth canal. This will resolve in a few days and does not need to be recorded.

Caput

When a baby has caput the scalp can become filled with fluid which is known as scalp edema. If pressure is applied to the scalp in a baby with caput, you will see the characteristic pitting shown in the photo. Caput is normal and does not need to be recorded.

Cephalohematoma

Cephalohematoma is a collection of blood which accumulates in the scalp and can result from trauma during birth. A cephalohematoma never crosses suture lines, and so is never present in the midline of the head (note the dip in the middle). It will feel fluctuant (soft, like a bag of liquid) on palpation. This does not need to be recorded.

Hydrocephalus

Photo credit: David Wrubel, MD

Hydrocephalus is an abnormal condition where cerebrospinal fluid collects in the ventricles of the brain which makes the head larger than normal. This should be marked on the form as part of the head examination.

Bruising

Bruising can occur to the head or face during delivery. It can be commonly seen as a consequence of difficult deliveries such as those babies born with a vacuum or forceps delivery. You may observe bruising to the head or face. This does not need to be recorded.

Face

Look at the baby's face and notice if it appears normal. When examining the face, you will check the eyes, ears, nose, mouth, and chin. If the face looks strange and you are unsure if the baby is normal or not, ask for the baby to be checked by the doctor or examiner.

Chin

Normal chin

Micrognathia (small chin)

Make sure the chin is normal. Sometimes babies can be born with a small or recessed chin. This is called micrognathia. It can make it difficult to breast feed the baby properly. It may be a sign that the baby has a genetic defect, and you should look carefully for other problems if you see this.

Mouth and palate

Check to see if the palate and mouth are normal. Look for the presence of cleft lip. To check the palate, use a clean finger (preferably with a glove on it) to feel the inside of the mouth for a cleft palate.

Baby with cleft lip

Baby with cleft palate

Lip and philtrum

A smooth philtrum can be associated with certain disorders and should be noted. When examining the philtrum, the infants face needs to be relaxed, the face should not be crying or smiling. Lack of philtrum and a thin upper lip as shown in the picture below are associated with fetal alcohol syndrome and should be noted.

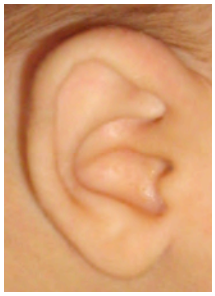
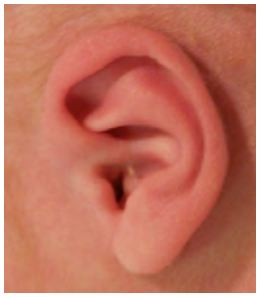
Nose

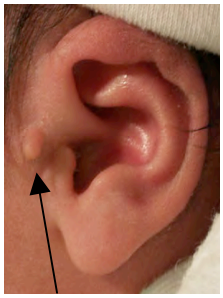
Verify that the nose has 2 nostrils and both nostrils are open.

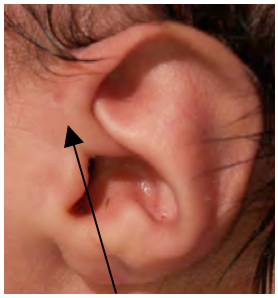
Choanal atresia (a blocked nostril) is checked by seeing if the infant can breathe through both nostrils. To check this, gently place a finger over ONE nostril to occlude (block) it. When the left nostril is closed, you are checking that the right side is open and the baby is able to breathe. Once you have blocked the left nostril, you should then block the right nostril. When the right nostril is blocked, you are checking that the baby can breathe through the left nostril. Infants do not know how to breathe through their mouths, so if the nose is obstructed, they will have difficulty breathing.

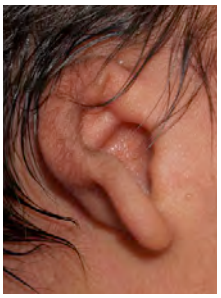
Ears

All abnormalities of the ear, including an ear tag, ear pit, abnormally shaped ear, or an ear which is too small should be recorded on the form, and a picture should be taken to document the abnormality.



Normal


Ear tag

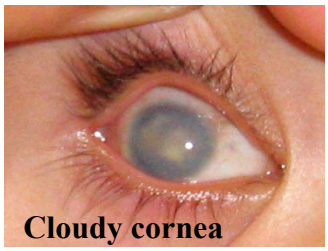

Ear pit


Microtia
(ear too small)

Eyes

The eyes should be clear. Newborn babies are sensitive to the light and therefore they tend to keep their eyes closed. If you shade the eyes with your hands, sometimes this creates enough protection from the light that the baby will open their eyes naturally and you can then examine them. If the eyes are cloudy, this suggests ccongenital cataracts, as shown in the picture on the right.

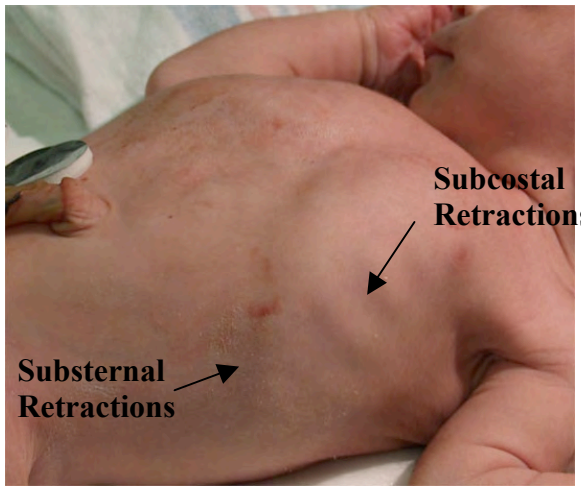

Normal eyes


Cloudy cornea

Chest

Look at the shape, symmetry, and location of the nipples. Also note if there are any accessory nipples.

Extra nipple (not significant and not necessary to report)



Chest Indrawing

While observing the chest, make a point to check if any of the following are present:

- Chest indrawing
- Nasal flaring
- Tracheal tug
- Head bobbing

These are signs of respiratory distress. If you notice a baby has any of these, ask for help! These symptoms should be recorded on the form under chest.

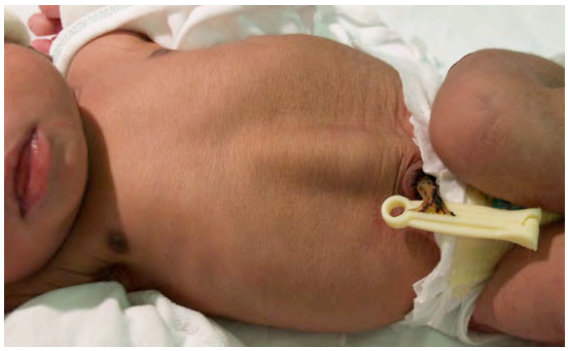
Abdomen

Normal Abdomen

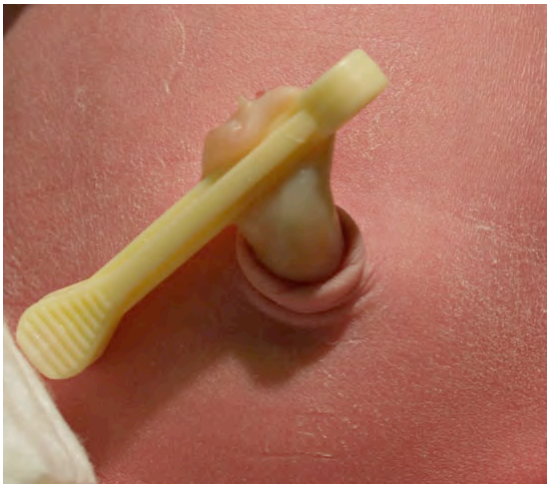
When conducting the abdominal examination, observe if the abdomen appears distended. If you believe the abdomen is distended, contact a medical doctor for further examination.

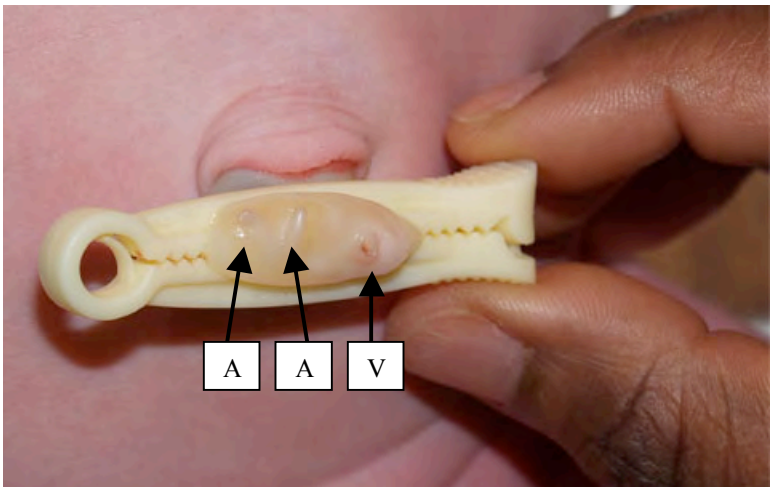
You should palpate (press on) the abdomen to make sure it is soft. If it is hard, or if you feel a mass, you should ask a doctor to check the baby.

Diastasis recti (also known as abdominal separation) is a disorder defined as a separation of the rectus abdominis muscle into right and left halves. You will see a bulge in the middle of the abdomen as shown in the picture. This is a NORMAL finding in a neonate and usually resolves over time. It does not need to be recorded.



Umbilicus

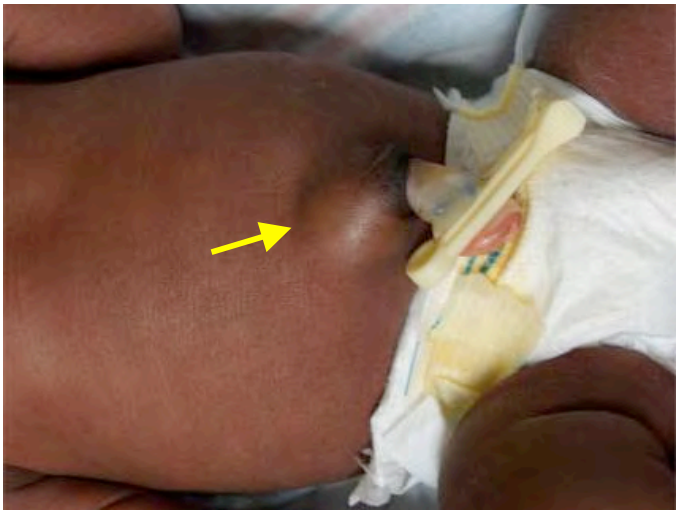




Careful inspection of the umbilicus should include checking the blood vessels. The umbilical cord usually has 3 blood vessels - 2 arteries (A) and 1 vein (V). The vein is the largest of the 3 vessels. Check if all 3 vessels are present. If only two are found, the baby is at risk of having other more serious congenital abnormalities and this should be noted on the form. If the baby is more than a few hours old, you may not be able to see any of the vessels.

Umbilical hernia

This is a defect in the muscles around the umbilicus, which can allow fluid and intestinal contents to bulge out. When you push on the bulge, it should return easily into the abdominal cavity (this is called "reducing a hernina"). If you cannot reduce the hernia, tell a doctor. If an umbilical hernia is small, it will resolve on its own. All umbilical hernias should be recorded on the form under 'Abdomen'.



Serious abdominal malformations
It is possible that a baby can be born with the internal organs on the outside the abdomen. There are 2 different types of malformations in which this occurs.

An **omphalocele** is a midline defect in which the internal organs protrude through the umbilicus. In this case, they are generally enclosed in a sac, although sometimes this sac will break during the birth process.

In **gastroschesis ,** the malformation is slightly off to the side, typically to the right of the umbilicus (a lateral rather than a midline defect), and the organs are not protruding through the umbilical cord. In gastroschesis, the internal organs are NOT enclosed in a sac.

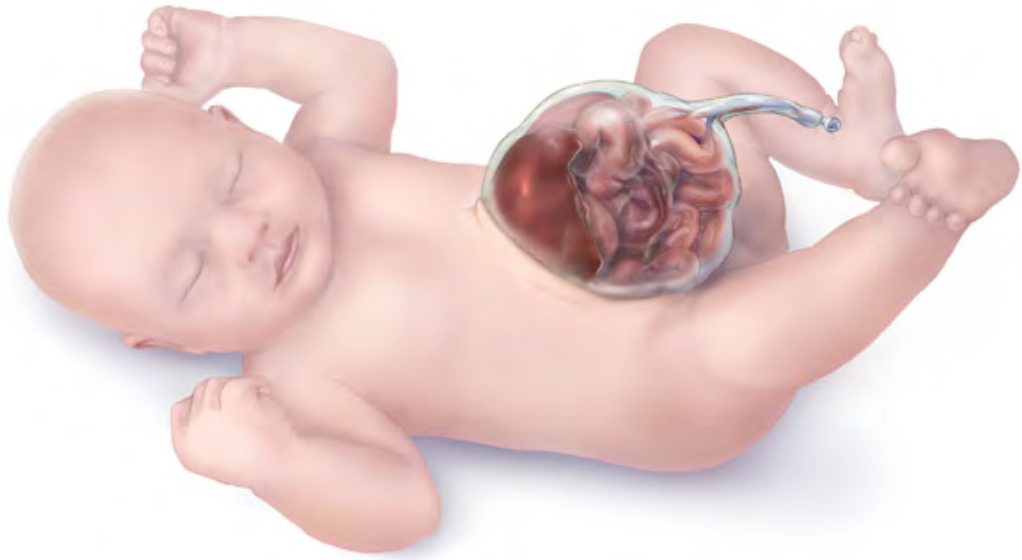
If either an omphalocele or gastroschisis is present, notify a clinician!!

Omphalocele

Gastroschesis

Below is a drawing of an infant with an **omphalocele**. Notice how the infant's intestine and other abdominal organs stick out of the belly button into the umbilical cord.

Omphalocele



Below is a drawing of an infant with **gastroschisis**. Notice how the infant's intestines protrude out of the body through a small hole in the abdominal wall beside the umbilical cord. The abdominal wall defect can be small or large and other organs such as the liver can also be involved.

Gastroschesis

Limbs

Observe the arms, legs, hands, feet, fingers and toes. Make sure there are 5 fingers on each hand and 5 toes on each foot.
If you find any abnormalities, describe them on the form. Don't forget to take a picture.

Normal limbs

Fingers
Syndactyly of fingers or toes mean that 2 digits are fused together, while polydactyly is the word used when there are more than 5 fingers or toes on one extremity.
Some babies may have a small "extra" finger dangling off from the side of the little finger. This is often attached by only a small piece of skin, and will usually fall off. A string can be tied tightly to speed the process of this falling off. This condition can be seen on the feet as well.

Post axial polydactyly (extra "dangling" finger)

Syndactyly (fused fingers)

Toes

Post axial polydactyly

Syndactyly (fused toes) and polydactyly

Talipes

Talipes is the medical word for an abnormal position of the foot. Many babies will hold their feet slightly turned in, however, you should easily be able to turn the feet so they are straight. This is known as **positional talipes** and occurs due to the baby being unable to move freely in the uterus, resulting in an abnormal position. This can be corrected by having the mother stretch the foot to the normal position several times a day.

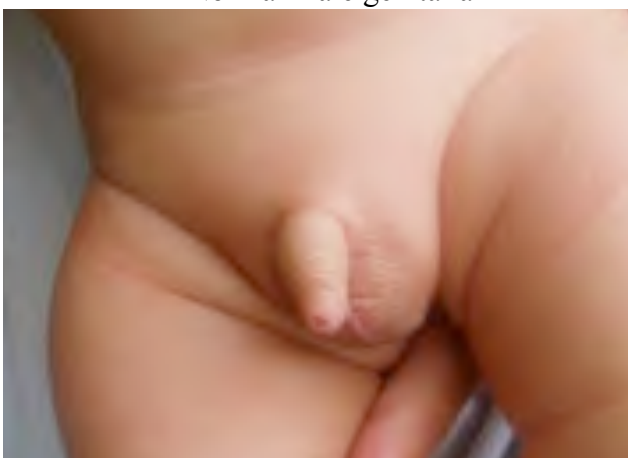
Talipes equinovarus, or Clubfoot, is a congenital condition where the foot turns inward and downward. If you apply pressure to the feet and cannot easily correct the in-turned position, it suggests club foot.

Club foot

Genital exam - Male

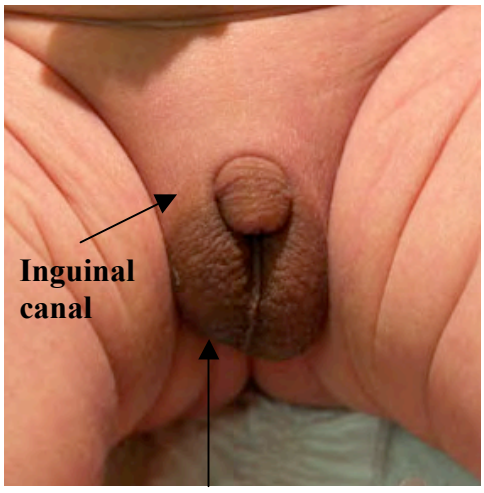
Check to see if the genitalia appear normal. Verify that both of the testes have descended. You should be able to feel the testes within the scrotum, in babies they are usually about 1 cm in size or a bit smaller. In babies, the testes will sometimes be drawn up into the groin (into the inguinal canal), but you should be able to gently bring the teste into the scrotal sac.

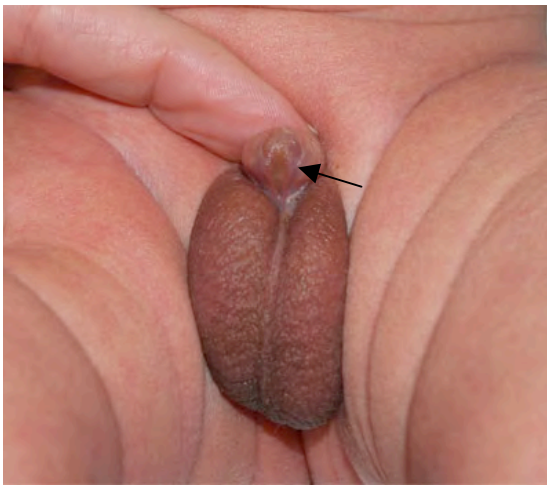
Normal male genitalia



Hypospadias

Hypospadias is an abnormal condition in boys in which the urethra (the opening where urine comes out) opens on the underside rather than at the tip or center of the penis. A 'hooded foreskin' strongly suggests the presence of hydrospadias. In the photo below, you can see how the penis opens on the underside of the shaft.





Swollen scrotal sac
Some newborn boys will have very large scrotal sacs. This suggests the presence of either a **hydrocele** or an **inguinal hernia**.

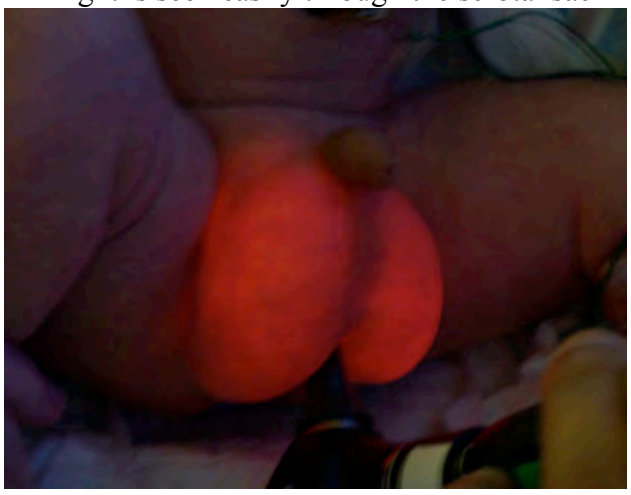
A **hydrocele** is fluid-filled sac surrounding the testicle, which is generally not harmful and not painful. Although enlarged, the hydrocele should feel soft and fluid filled, and will not be painful or red. When you palpate the scrotum, you should notice that the testicles are present within the fluid filled sac, although they will be small (about the size of a pea). Pressing on the scrotum will generally not reduce the size of the scrotal swelling.

An **inguinal hernia** occurs when there is a connection between the abdomen and the scrotum, which can allow intestinal contents to enter the scrotum. In general, you can push the abdominal contents back into the abdomen by applying gentle pressure to the sac (reducing the hernia). Once you let go, however, the sac will usually refill. This should not cause the child pain. Sometimes, the bowels can get stuck inside the scrotal sac. If this occurs, you may not be easily able to push the contents back into the abdominal cavity. If the bowels become stuck inside the scrotal sac, the blood supply to the intestine may be decreased, which can result in death of that part of the intestine. If part of the intestines die, this may be painful. This is very serious and may be life threatening.

A hydrocele generally feels softer than a hernia. In order to differentiate the two, you can shine a light onto the scrotal sac. Place the light on the underside of the scrotal sac. If the light shines through, as in the picture, this is more suggestive of a hydrocele.

Hydrocele

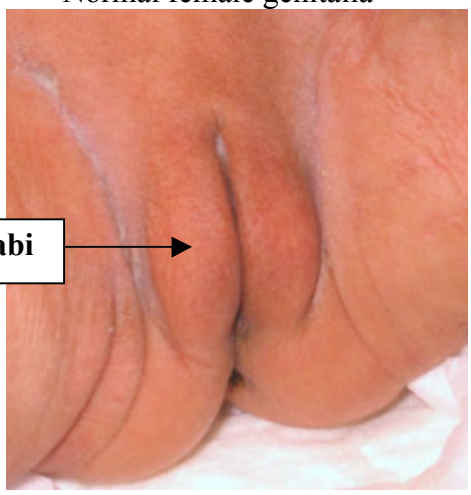
lllumination of a hydrocele- note that the light is seen easily through the scrotal sac



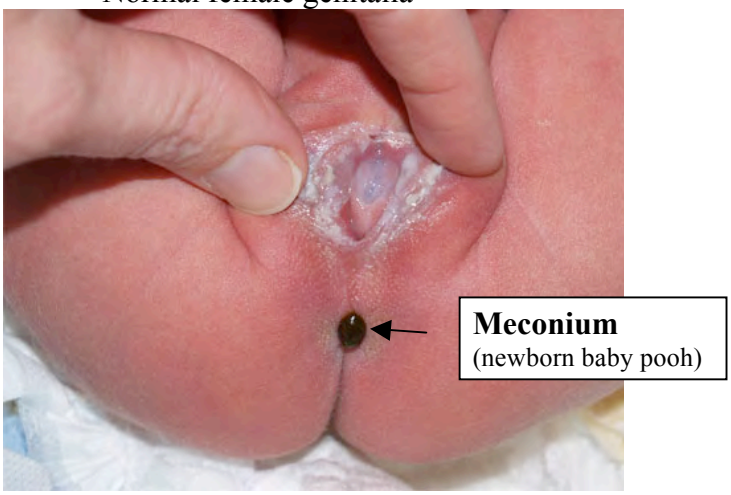
Genital exam – Female

Female infants may have some whitish discharge or even small amounts of blood from the vagina - this is normal. When examining the female genitalia, try to separate the labia as shown in the photo on the right. This will allow you to identify if the labia are fused (stuck together).

Normal female genitalia



Normal female genitalia



Anus

An **imperforate anus** is a congenital defect of the anus; there is partial or complete obstruction of the anal opening. During the exam, you should verify that the baby's anus is patent (open). This can be done by stretching the bottom apart with 2 fingers to look at the opening. If you suspect an imperforate anus, you should ask a doctor to see the baby right away!
Note in the photo on the right, there is no opening for the anus. A baby with imperforate anus may still pass meconium if there is another associated abnormality, such as an abnormal connection between the vagina and rectum (recto-vaginal fistula). Therefore, even if you see meconium, you still need to verify the presence of an anal opening.

Normal anus

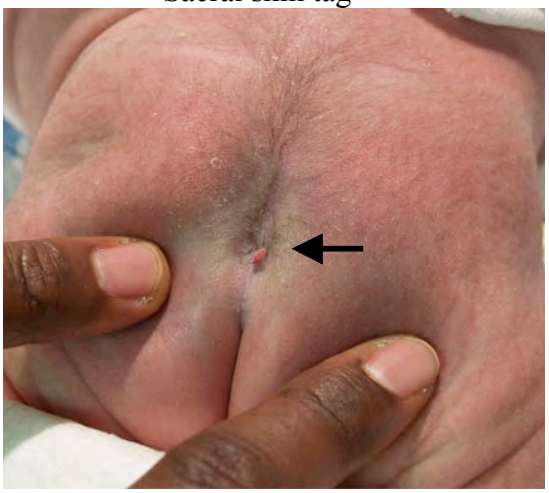
Imperforate anus

Back and spine

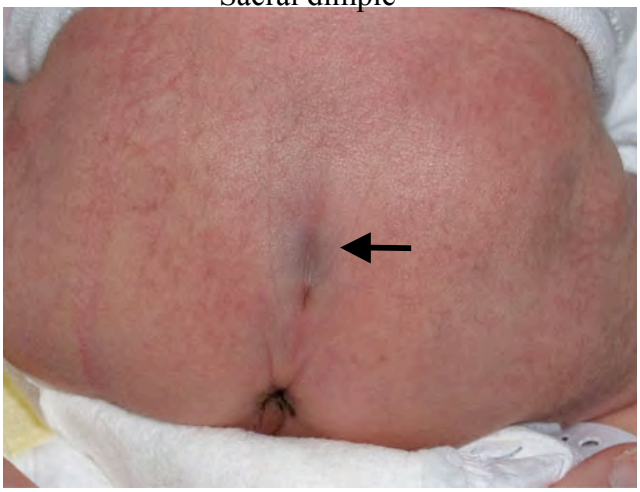
Look at the baby's back. Pay careful attention to any abnormalities which might be located along the midline or along the spine. Look for birthmarks, dimples, or tufts of hair along the spine. These may be a sign of a more serious problem such as Spina Bifida. Examine the spine to make sure there are no abnormalities in the bones. Any abnormalities that you find along the midline of the back should be recorded, including any dimples or pits, skin tags, tufts of hair, or anything else which does not look normal. You should also take a picture to document the abnormality.

Normal back

Sacral skin tag



Sacral dimple



Saccrococcygeal teratoma

A teratoma is a germ cell tumor found in the midline of the body. In newborns, the most common location where these tumors occur is at the sacrococcygeal region, at the base of the spine. This is a mass of tissue which protrudes from the back, and does not come out of the spinal cord as in Spina Bifida.

Neural tube defects

The neural tube is a narrow channel that folds and closes during the 3rd and 4th weeks of pregnancy to form the brain and spinal cord. Incomplete closure of this tube results in several different birth defects:

- Anencephaly
- Encephlomyelocele
- Spina Bifida

Anencephaly – this birth defect is characterized by a baby missing parts of the brain, skull, and scalp. Babies with this condition often are born without the thinking part of the brain. The remaining brain tissue is often exposed, meaning, it is not covered by bone or skin.

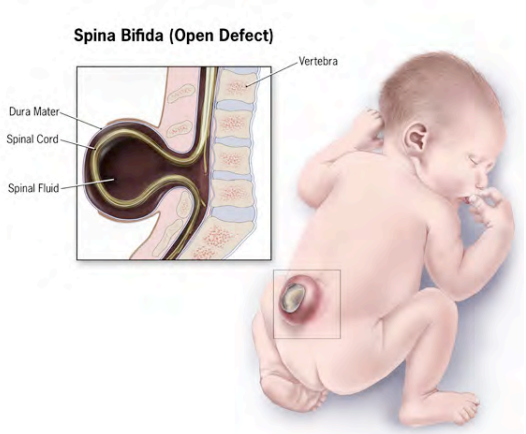
Encephalocele is a sac-like protrusion of the brain through an opening in the midline of the skull.

Anencephaly

Encephalocele

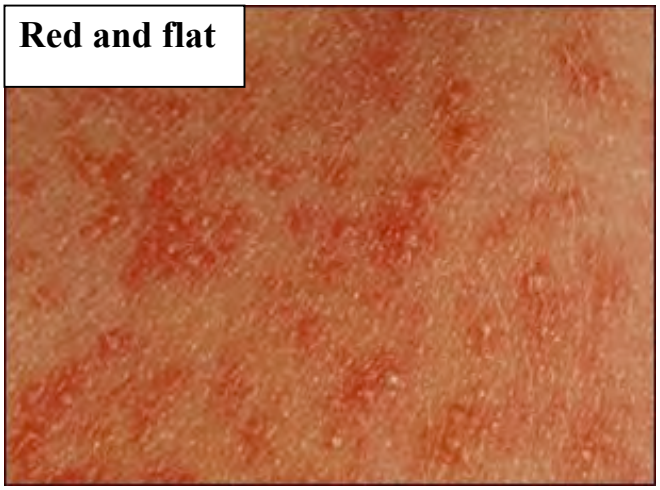
Spina bifida

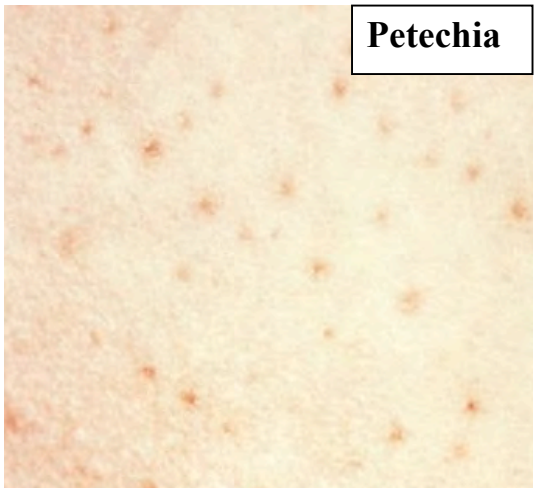
Spina bifida is a malformation where the bones around the spinal cord do not close all the way. Sometimes, the skin is open as well, and the spinal cord is exposed.
If you see this, tell a clinician!

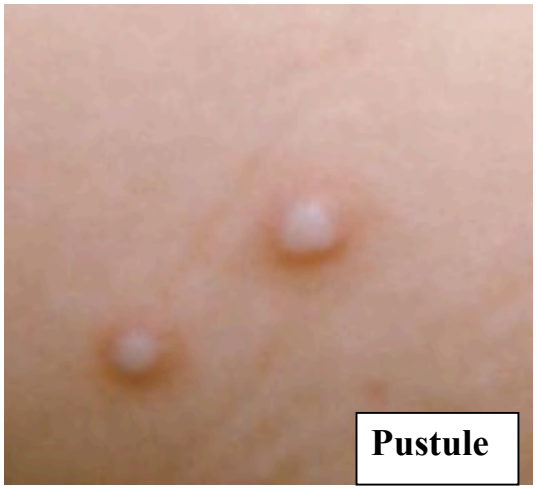


Skin

There are many different types of rashes commonly seen in newborns. Rashes do not need to be recorded on the examination form. However, since you are examining the baby, the parents may ask you about the rashes. Rashes may be described with words such as: Red, Raised, Flat, or Pustules. Areas of red skin may be due to heat, rubbing against the clothing, allergies or other causes; pustules, vesicles (which contain clear fluid), and petechiae typically indicate an infection or more severe problem with the baby and should be seen by a doctor.





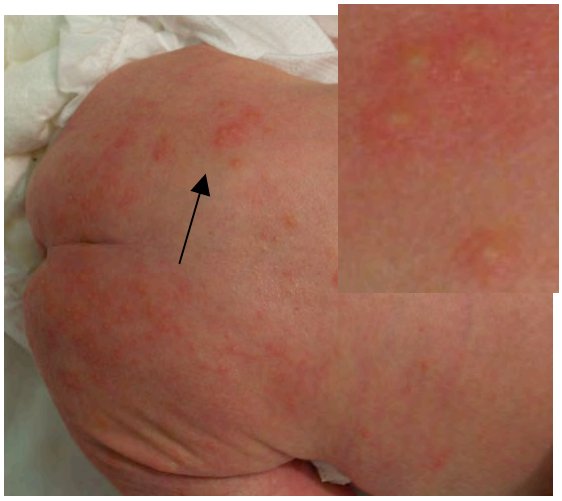


Normal newborn rashes

Many babies will have rashes at or shortly after birth. The most common of these are milia and erythema toxicum. Some babies will also have neonatal acne.

Milia are small white spots usually found on the face. These will go away without treatment in a few weeks. Erythema toxicum are very small pustules on a red base. The fluid in these lesions is full of eosinophils, a type of white blood cells. This rash will also go away without treatment. However, herpes simplex virus can also cause a pustular rash, and can be very serious in babies. If you are unsure what the rash is, please ask a doctor to look at it.

Milia



Erythema toxicum

Birthmarks

Birthmarks do not need to be recorded on the examination form. But like rashes, parents may ask you about it. Mongolian spots are blue marks which are commonly found on the buttocks. A red mark on the back of the neck, or above the eyes is referred to as a stork bite. Both of these birthmarks are fairly common and are not dangerous.

Mongolian spots

Stork bite

Neurological examination

As part of the newborn assessment, you also need to conduct a neurological examination and check that the muscles and nerves are functioning normally. Note if the infant appears to have normal muscle tone, or, if the infant appears too floppy or too stiff. A normal newborn will not be able to hold his or her head up, but will generally not be as floppy as the infant shown in the picture below. You should also make sure that the infant is moving all of the limbs normally. If you startle the infant with a loud noise, he or she should startle, and extend both arms and both legs. This is called a "moro" response and is normal. Also test that the baby is able to suck normally. This can be done by observing him or her feed or by allowing him to suck on a pacifier or your finger. If anything appears strange, please describe your findings.

Hypotonia (decreased muscle tone)

Photo credit: http://library.med.utah.edu/pedineurologicexam/

IV. SUMMARY OF THE NEWBORN EXAMINATION

In conclusion, never be worried to ask a doctor or medic to see a child if you suspect the child has an abnormality. If you are unsure if an abnormality is present, or if you suspect one, a doctor must be notified. In addition, please take a picture of any suspected abnormalities and document them on the form.

A routine physical examination takes only a few minutes and should be carried out on ALL infants as soon as possible after birth. All babies should have an exam in the first week of life. Many of the serious correctable congenital malformations can be detected at birth or within a few days. Early diagnosis of certain abnormalities greatly increases the chances of survival and can greatly reduce permanent residual disability.

V. THE NEW BALLARD SCORE

Adapted from: Ballard JL, Khoury JC, Wedig K, et al: New Ballard Score, expanded to include extremely premature infants. J Pediatrics 1991; 119:417-423.

Overview

The gestational age of a fetus or of a newborn can be assessed by three different methods: the mother's menstrual history (date of last menstrual period, or LMP), prenatal ultrasonography, and the postnatal maturational examination. This manual describes how to conduct a postnatal maturational examination using the Ballard Score method to determine a newborn's gestational age.

An accurate menstrual history, when obtainable, remains the best measure of gestational age, but depends upon normal maternal physiology and an accurate and reliable history.

The prenatal ultrasound examination is one indirect method of assessing the gestational age of the fetus. It uses fetal body part measurements to estimate gestational age, and therefore it relies upon normally timed and proportioned fetal growth rates. When performed early in gestation (first trimester), fetal ultrasound is a highly accurate method of assessing gestational age. As the developing fetus is exposed to a variety of intrauterine influences, fetal growth may be affected in a variety of ways.[1] As the fetus gets older, the ultrasound measurements become less reliable in estimating gestational age. Therefore, late trimester ultrasound measurements provide an inaccurate measure of fetal gestational age.[2,3]

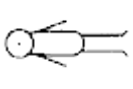
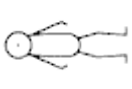
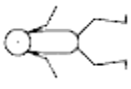
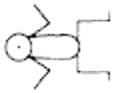
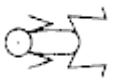
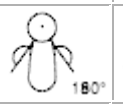
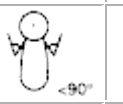
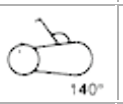
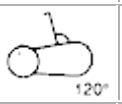
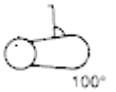
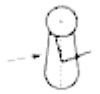
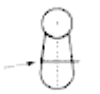
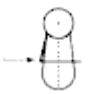
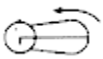
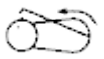
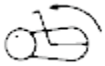
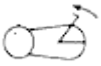
The Ballard examination should ideally be performed between 12 and 24 hours of life, but remains reasonably accurate up to 5- 7 days of life.[4] It is accurate to +/- 2 weeks gestational age. It is an indirect method of assessing gestational age based upon indicators of fetal neuromuscular and physical maturation.[5] As with fetal growth, fetal maturation may be influenced by a variety of intrauterine experiences. Stressful fetal experiences may accelerate lung[6] and neuromuscular rates[7] of maturation while slowing or not affecting physical maturation. A completely non-stressed fetus may mature more slowly than the average fetus. The same events that accelerate fetal maturation may adversely affect fetal growth. Conversely, those that accelerate fetal growth may delay its maturation.

Since certain fetal stresses may occur without the patient's or the physician's knowledge, the assessment of gestational age by maturational exam can also be inaccurate.

However, the neonatal maturational examination still remains the most universally accepted method of assessing gestational age after birth.

Ballard examination (score sheet)

NEUROMUSCULAR MATURITY

NEUROMUSCULAR MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
POSTURE								
SQUARE WINDOW (Wrist)								
ARM RECOIL								
POPLITEAL ANGLE								
SCARF SIGN								
HEEL TO EAR								
							TOTAL NEUROMUSCULAR MATURITY SCORE	

PHYSICAL MATURITY

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
SKIN	sticky, friable, transparent	gelatinous, red, translucent	smooth pink, visible veins	superficial peeling &/or rash, few veins	cracking, pale areas, rare veins	parchment, deep cracking, no vessels	leathery, cracked, wrinkled	
LANUGO	None	Sparse	Abundant	Thinning	bald areas	mostly bald		
PLANTAR SURFACE	heel-toe 40-50 mm: -1 <40 mm: -2	>50 mm no crease	faint red marks	anterior transverse crease only	creases ant. 2/3	creases over entire sole		
BREAST	Imperceptible	barely perceptible	flat areola no bud	stippled areola 1-2 mm bud	raised areola 3-4 mm bud	full areola 5-10 mm bud		
EYE / EAR	lids fused loosely: -1 tightly: -2	lids open pinna flat stays folded	sl. curved pinna; soft; slow recoil	well-curved pinna; soft but ready recoil	formed & firm instant recoil	thick cartilage ear stiff		
GENITALS (Male)	scrotum flat, smooth	scrotum empty, faint rugae	testes in upper canal, rare rugae	testes descending, few rugae	testes down, good rugae	testes pendulous, deep rugae		
GENITALS (Female)	clitoris prominent & labia flat	prominent clitoris & small labia minora	prominent clitoris & enlarging minora	majora & minora equally prominent	majora large, minora small	majora cover clitoris & minora		
							TOTAL PHYSICAL MATURITY SCORE	

Maturational assessment of gestational age - Neuromuscular assessment

Neuromuscular maturation and neonatal muscle tone

Fetal brain development is a very complex process, and problems can occur at any stage of the process. Any disruption of the normal intrauterine environment can affect the balance between growth and differentiation of neural tissue and thus affect the rate of functional maturation of the developing fetal brain. Tests of neuromuscular maturation indirectly assess brain maturity, which in turn gives us an indirect measure of gestational age.

Neonatal muscle tone

Muscle tone is due to continuous and passive partial contraction of the muscles. This helps to maintain posture.

The newborn's neuromuscular examination includes an assessment of both active and passive muscle tone. If all newborns were normal and healthy, both active and passive tone could be used routinely to assess neuromuscular maturation. Active muscle tone, (motility, activity, or efforts at righting oneself) is markedly affected by states of illness, recent maternal medications, acute perinatal compromise and level of alertness. Hence, active muscle tone is not consistently useful in evaluating baseline neuromuscular maturity. Passive tone (resistance to passive movement- i.e. to manipulation by the examiner) is essentially unaffected by those factors that profoundly affect active tone. Hence passive tone is useful for evaluating maturational development of the neonatal brain, regardless of the infant's state of alertness or level of wellness.

Passive tone may be further subdivided into extensor and flexor tone. The human fetus, lying primarily with limbs extended (straight) in the very early phases of development, gradually assumes a progressively flexed position (limbs bent). This is true whether development occurs in utero or in the nursery, and thus reflects maturation of the central nervous system rather than extraneous compressive forces of the uterus.[8] Passive flexor tone gradually overcomes passive extensor tone as the baby matures. Premature babies lie with their extremities stretched out, while term babies keep arms and legs bent. Progression of neuromuscular tone development proceeds from foot to head and from the extremities to the trunk.[8]

There are three possible methods of assessing passive flexor tone in the neonate. The first is extensor stretch or *passive flexion*, which may better be described as flexibility, and is used to evaluate the degree to which a limb can be flexed passively at the joint by the examiner. This maneuver requires no tone or extensor resistance on the part of the infant. We may be looking at mobility, flexibility or resistance to extensor stretch rather than at passive flexor tone.

The second method of assessing passive flexor tone is *resistance to passive extension*. These maneuvers require:

a) That the untested portion of the extremity be resting quietly on a supporting surface;

b) That the examiner be very sensitive to the infant's slight tendency to resist extension; and

c) That the examiner avoid placing pressure on flexors being tested, thereby interfering with their function.

The third method of testing passive flexor tone is measurement of *angles of recoil* to a previously flexed position. This maneuver requires that the examiner;

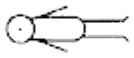
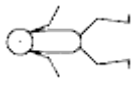
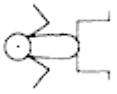
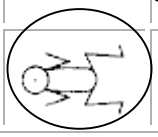
a) Pre-set the extremity to a flexed position; and

b) Avoid fatiguing the flexors by maintaining the extremity straight for too long a period of time prior to releasing.

1. Posture

Total body muscle tone is reflected in the infant's preferred posture at rest and resistance to stretch of individual muscle groups. As maturation progresses, the fetus gradually assumes increasing passive flexor tone that proceeds from outwards in, with lower extremities slightly ahead of upper extremities. For example, very early in gestation only the ankles are flexed. Knees will flex as wrists just begin to flex. Hip flexion, then abduction are just ahead of elbow, then shoulder girdle flexion. The preterm infant will generally lie with all extremities straight, while the infant approaching term keeps all extremities bent.

To elicit the posture item, the infant is placed on his or her back and the examiner waits until the infant settles into a relaxed or preferred posture. If the infant is already lying on his or her back, gentle manipulation of the extremities will allow the infant to seek the baseline position of comfort. Bending of the hips (flexion) without abduction results in the frog-leg position as depicted in posture square #3. Hip abduction accompanying flexion is depicted by the acute angle at the hips in posture square #4. The figure that most closely depicts the infant's preferred posture is selected.

SIGN	NEURO-MUSCULAR MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Posture								4

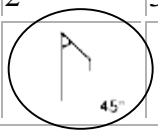
2. Square window

Wrist flexibility and/or resistance to extensor stretching are responsible for the resulting angle of flexion at the wrist.

The examiner straightens the infant's fingers and applies gentle pressure on the dorsum (back) of the hand, close to the fingers. From extremely pre-term to post-term, the resulting angle between the palm of the infant's hand and forearm is estimated at;

>90°, 90°, 60°, 45°, 30°, and 0°.

The appropriate square on the score sheet is selected.

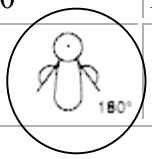
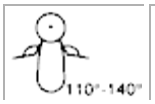
SIGN	NEURO-MUSCULAR MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Square Window								2

3. Arm recoil

This maneuver focuses on passive flexor tone of the biceps muscle by measuring the angle of recoil following very brief extension of the upper extremity.

With the infant lying on his or her back, the examiner places one hand beneath the infant's elbow for support. Taking the infant's hand, the examiner briefly bends the arm at the elbow, then momentarily straightens the arm, and then releases the hand. The more mature baby will bring the arm back to a bent position. The angle of recoil to which the forearm springs back into flexion is noted, and the appropriate square is selected on the score sheet. The extremely pre-term infant will not exhibit any arm recoil. Square #4 is selected only if there is contact between the infant's fist and face. This is seen in term and post term infants.

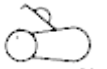
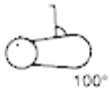
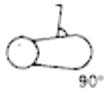
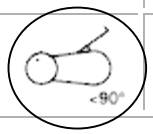
Care must be taken not to hold the arm in the extended position for a prolonged period, as this causes flexor fatigue and results in a falsely low score due to poor flexor recoil.

SIGN	NEURO-MUSCULAR MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Arm Recoil								0

4. Popliteal angle

This maneuver assesses maturation of passive flexor tone about the knee joint by testing for resistance to extension of the lower extremity. With the infant lying supine (on the back), and with diaper removed, the thigh is placed gently on the infant's abdomen with the knee fully flexed (bent). After the infant has relaxed into this position, the examiner gently grasps the foot at the sides with one hand while supporting the side of the thigh with the other. Care is taken not to exert pressure on the hamstrings, as this may interfere with their function. The leg is extended until a definite resistance to extension is appreciated. In some infants, hamstring contraction may be visualized during this maneuver. At this point the angle formed at the knee by the upper and lower leg is measured.

Note: a) It is important that the examiner wait until the infant stops kicking actively before extending the leg. b) The prenatal frank breech position will interfere with this maneuver for the first 24 to 48 hours of age due to prolonged intrauterine flexor fatigue. The test should be repeated once recovery has occurred; alternately, a score similar to those obtained for other items in the exam may be assigned.

SIGN	NEURO-MUSCULAR MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Popliteal Angle								5

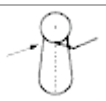
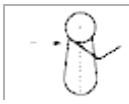
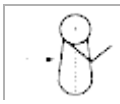
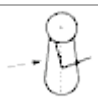
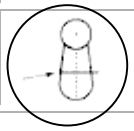
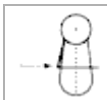
5. Scarf sign

This maneuver tests the passive tone of the flexors about the shoulder girdle.

With the infant lying supine (on the back), the examiner adjusts the infant's head to the midline and supports the infant's hand across the upper chest with one hand. The thumb of the examiner's other hand is placed on the infant's elbow.

The examiner nudges the elbow across the chest, feeling for passive flexion or resistance to extension of posterior shoulder girdle flexor muscles.

The point on the chest to which the elbow moves easily prior to significant resistance is noted. Landmarks noted in order of increasing maturity are: full scarf at the level of the neck (-1); contralateral (opposite side) axillary line (0); contralateral nipple line (1); xyphoid process (2); ipsilateral (same side) nipple line (3); and ipsilateral axillary line (4).

SIGN	NEURO-MUSCULAR MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Scarf Sign								3

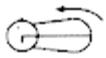
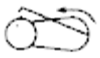
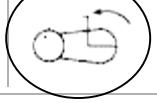
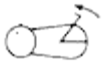
6. Heel to ear

This maneuver measures passive flexor tone about the pelvic girdle by testing for passive flexion or resistance to extension of posterior hip flexor muscles.

The infant is placed supine (on his/her back) and the flexed lower extremity is brought to rest on the mattress alongside the infant's trunk.

The examiner supports the infant's thigh laterally alongside the body with the palm of one hand. The other hand is used to grasp the infant's foot at the sides and to pull it toward the ipsilateral ear (on the same side of the body).

The examiner feels for resistance to extension of the posterior pelvic girdle flexors and notes the location of the heel where significant resistance is appreciated. Landmarks noted in order of increasing maturity include resistance felt when the heel is at or near the: ear (-1); nose (0); chin level (1); nipple line (2); umbilical area (3); and femoral crease (4).

SIGN	NEURO-MUSCULAR MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Heel To Ear								3

Maturational assessment of gestational age - Physical assessment

1. Skin

Maturation of fetal skin involves the development of its intrinsic structures concurrent with the gradual loss of its protective coating, the vernix caseosa. Therefore, the skin thickens, dries and becomes wrinkled and/or peels, and may develop a rash as fetal maturation progresses. These phenomena may occur at varying paces in individual fetuses depending in part upon the maternal condition and the intrauterine environment.

Before the development of the epidermis with its stratum corneum, the skin is transparent and adheres somewhat to the examiner's finger. Later it smoothes, thickens and produces a lubricant, the vernix, that dissipates toward the end of gestation.

At term and post-term, the fetus may expel meconium into the amniotic fluid. This may add an accelerating effect to the drying process, causing peeling, cracking, dehydration, and imparting a parchment, then leathery, appearance to the skin. For scoring purposes, the square which describes the infant's skin the most closely should be selected.

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Skin	Sticky, friable, transparent	gelatinous, red, translucent	smooth pink, visible veins	superficial peeling &/or rash, few veins	cracking, pale areas, rare veins	parchment, deep cracking, no vessels	leathery, cracked, wrinkled	4

2. Lanugo

Lanugo is the fine hair covering the body of the fetus.

In extreme immaturity, the skin lacks any lanugo. It begins to appear at approximately the 24th to 25th week and is usually abundant, especially across the shoulders and upper back, by the 28th week of gestation.

Thinning occurs first over the lower back, wearing away as the fetal body curves forward into its mature, flexed position. Bald areas appear and become larger over the lumbo-sacral area. At term, most of the fetal back is devoid of lanugo, i.e., the back is mostly bald.

Variability in amount and location of lanugo at a given gestational age may be attributed in part to familial or national traits and to certain hormonal, metabolic, and nutritional influences. For example, infants of diabetic mothers characteristically have abundant lanugo on their pinnae and upper back until close to or beyond full-term gestation. When scoring for lanugo, the examiner selects the square that most closely describes the relative amounts of lanugo on the upper and lower areas of the infant's back.

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Lanugo	none	sparse	abundant	thinning	bald areas	mostly bald		2

3. Plantar surface

This item pertains to the major foot creases on the sole of the foot. The first appearance of a crease appears on the anterior sole at the ball of the foot. This may be related to foot flexion in utero, but is contributed to by dehydration of the skin. Infants of non-white origin have been reported to have fewer foot creases at birth.[9] There is no known explanation for this.

On the other hand, the reported acceleration of neuromuscular maturity in black infants usually compensates for this, resulting in a cancellation of the delayed foot crease effect. Hence, there is usually no over- or under-estimation of gestational age due to race when the total score is performed.[10]

Very premature and extremely immature infants have no detectable foot creases. To further help define the gestational age of these infants, measuring the foot length or heel-toe distance is helpful.[10,11] This is done by placing the infant's foot on a metric tape measure and noting the distance from the back of the heel to the tip of the great toe. For heel-toe distances less than 40 mm, a minus two score (-2) is assigned; for those between 40 and 50 mm, a minus one score (-1) is assigned.

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Plantar Surface	heel-toe 40-50mm: -1 <40mm: -2	>50 mm no crease	faint red marks	anterior transverse crease only	creases ant. 2/3	creases over entire sole		4

4. Breast

The breast bud consists of breast tissue that is stimulated to grow by maternal estrogens and fatty tissue which is dependent upon fetal nutritional status. The examiner notes the size of the areola and the presence or absence of stippling (created by the developing papillae of Montgomery). The examiner then palpates the breast tissue beneath the skin by holding it between thumb and forefinger, estimating its diameter in millimeters, and selects the appropriate square on the score sheet.

Under- and over-nutrition of the fetus may affect breast size variation at a given gestation. Maternal estrogen effect may produce neonatal gynecomastia on the second to fourth day of extrauterine life.

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Breast	imperceptable	barely perceptable	flat areola no bud	stippled areola 1-2 mm bud	raised areola 3-4 mm bud	full areola 5-10 mm bud		3

5. Eye / Ear

The pinna of the fetal ear changes it configuration and increases in cartilage content as maturation progresses. Assessment includes palpation for cartilage thickness, then folding the pinna forward toward the face and releasing it. The examiner notes the rapidity with which the folded pinna snaps back away from the face when released, then selects the square that most closely describes the degree of cartilagenous development.

In very premature infants, the pinnae may remain folded when released. In such infants, the examiner notes the state of eyelid development as an additional indicator of fetal maturation.[12] The examiner places thumb and forefinger on the upper and lower lids, gently moving them apart to separate them. The extremely immature infant will have tightly fused eyelids, i.e., the examiner will not be able to separate either palpebral fissure with gentle traction. The slightly more mature infant will have one or both eyelids fused but one or both will be partly separable by the light traction of the examiner's fingertips. These findings will allow the examiner to select on the score sheet a minus two (-2) for slightly fused, or minus one (-1) for loosely or partially fused eyelids. The examiner should not be surprised to find a wide variation in eyelid fusion status in individual infants at a given gestational age, as the rate of eyelid un-fusion may be affected by certain stress-related intrauterine and humoral factors.[13]

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Eye / Ear	lids fused loosely:-1 tightly: -2	lids open pinna flat stays folded	sl. curved pinna; soft; slow recoil	well-curved pinna; soft but ready recoil	formed & firm instant recoil	thick cartilage ear stiff		-2

6. Genitals-Male

The fetal testicles begin their descent from the peritoneal cavity (in the abdomen) into the scrotal sack at approximately the 30th week of gestation. The left testicle precedes the right and usually enters the scrotum during the 32nd week. Both testicles are usually palpable in the upper to lower inguinal canals by the end of the 33rd to 34th weeks of gestation. Concurrently, the scrotal skin thickens and develops deeper and more numerous rugae (ridges/wrinkles).

Testicles found inside the rugated zone are considered descended. In extreme prematurity the scrotum is flat, smooth and appears sexually undifferentiated. At term to post-term, the scrotum may become pendulous and may actually touch the mattress when the infant lies supine (on the back). Note: In true cryptorchidism, the scrotum on the affected side appears uninhabited, hypoplastic and with underdeveloped rugae compared to the normal side, or, for a given gestation, when bilateral. In such a case, the normal side should be scored, or if bilateral, a score similar to that obtained for the other maturational criteria should be assigned.

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Genitals (Male)	scrotum flat, smooth	scrotum empty, faint rugae	testes in upper canal, rare rugae	testes descending, few rugae	testes down, good rugae	testes pendulous, deep rugae		3

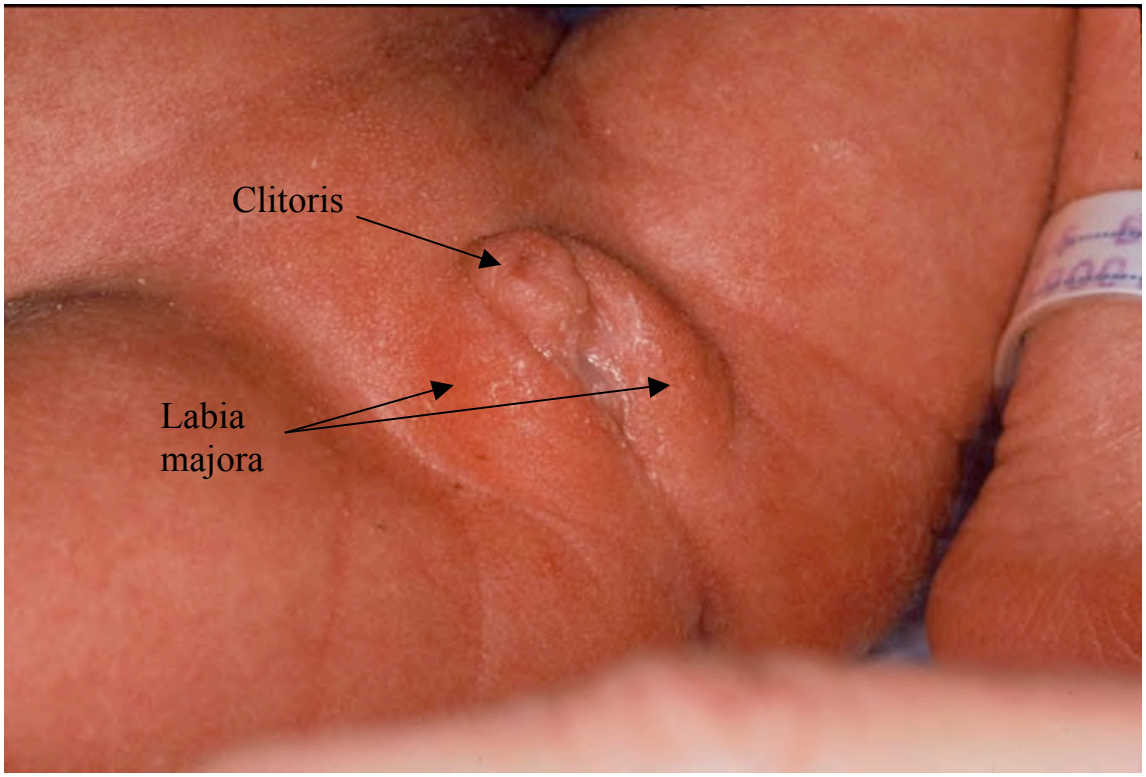
7. Genitals-Female

To examine the infant female, the hips should be only partially abducted, i.e., to approximately 45° from the horizontal with the infant lying supine (on the back). Exaggerated abduction (i.e. opening the legs too wide) may cause the clitoris and labia minora to appear more prominent, whereas adduction (bringing the legs together) may cause the labia majora to cover over them.

In extreme prematurity, the labia are flat and the clitoris is very prominent and may resemble the male phallus. As maturation progresses, the clitoris becomes less prominent and labia minora become more prominent. Nearing term, both clitoris and labia minora recede and are eventually enveloped by the enlarging labia majora.

The labia majora contain fat and their size is affected by intrauterine nutrition. Over-nutrition may result in large labia majora earlier in gestation, whereas under-nutrition, as in intrauterine growth retardation or post-maturity, may result in small labia majora with relatively prominent clitoris and labia minora late into gestation. These findings should be reported as observed, since a lower score on this item in the chronically stressed or growth retarded fetus may be counter-balanced by a higher score on certain neuromuscular items.

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Genitals (Female)	clitoris prominent & labia flat	prominent clitoris & small labia minora	prominent clitoris & enlarging minora	majora & minora equally prominent	majora large, minora small	majora cover clitoris & minora		-1



Summary of the New Ballard score monograph

The sum of all 12 criteria represents the neuromuscular and physical maturation of the fetus. When compared to the grid on the score sheet, the score denotes the infant's gestational age by maturational examination.

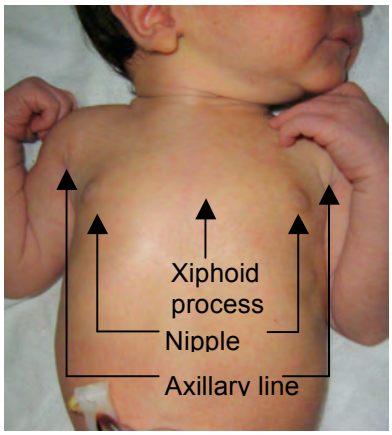
The maturational assessment of gestational age is a clinical tool that may be influenced by certain biological factors. A working knowledge of the assessment tool includes a knowledge of the standardized method for performing the exam, and an awareness of those intrauterine factors that influence the neuromuscular and physical maturational rates of the fetus. This approach increases the accuracy and validity of the tool and facilitates the examiner's understanding and interpretation of the score.

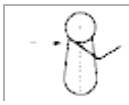
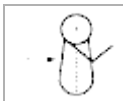
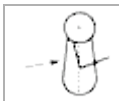
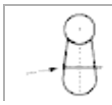
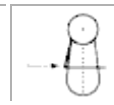
MATURITY RATING

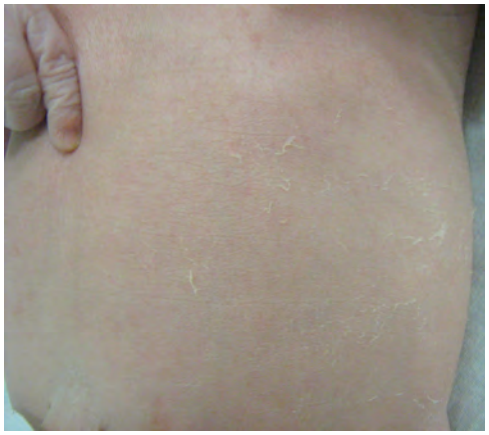
TOTAL SCORE (NEUROMUSCULAR + PHYSICAL)	WEEKS
-10	20
-5	22
0	24
5	26
10	28
15	30
20	32
25	34
30	36
35	38
40	40
45	42
50	44

Additional examples of Ballard assessment

SIGN	NEURO-MUSCULAR MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Square Window								



SIGN	NEURO-MUSCULAR MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Scarf Sign								

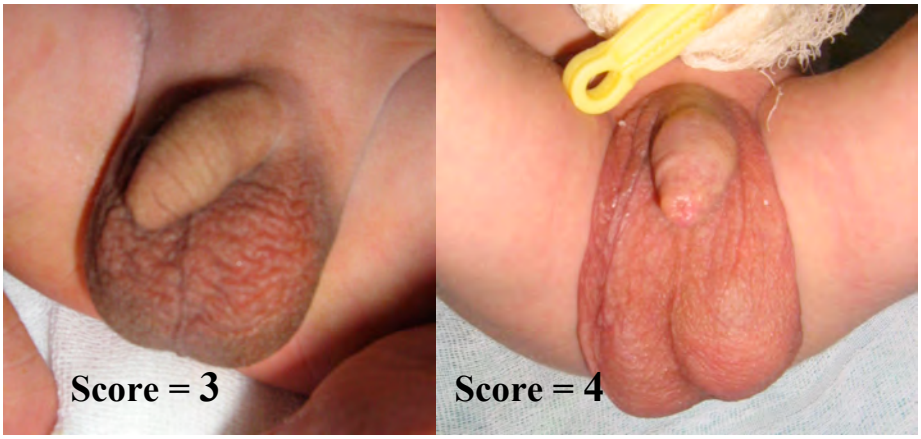


SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Skin	Sticky, friable, transparent	gelatinous, red, translucent	smooth pink, visible veins	superficial peeling &/or rash, few veins	cracking, pale areas, rare veins	parchment, deep cracking, no vessels	leathery, cracked, wrinkled	3

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Lanugo	none	sparse	abundant	thinning	bald areas	mostly bald		1

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Plantar Surface	heel-toe 40-50mm: -1 <40mm: -2	>50 mm no crease	faint red marks	anterior transverse crease only	creases ant. 2/3	creases over entire sole		3

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Eye / Ear	lids fused loosely:-1 tightly: -2	lids open pinna flat stays folded	sl. curved pinna; soft; slow recoil	well-curved pinna; soft but ready recoil	formed & firm instant recoil	thick cartilage ear stiff		3



SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Genitals (Male)	scrotum flat, smooth	scrotum empty, faint rugae	testes in upper canal, rare rugae	testes descending, few rugae	testes down, good rugae	testes pendulous, deep rugae		

SIGN	PHYSICAL MATURITY SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Genitals (Female)	clitoris prominent & labia flat	prominent clitoris & small labia minora	prominent clitoris & enlarging minora	majora & minora equally prominent	majora large, minora small	majora cover clitoris & minora		3

VI. NEWBORN EXAMINATION REFERENCES

1. Nelson K, Holmes LB. Malformations due to presumed spontaneous mutations in newborn infants. N Engl J Med 320:19-23, 1989.
2. Peller AJ, Westgate M-N, Holmes LB. Trends in congenital malformations, 1974-1999: Effect of prenatal diagnosis and elective termination. Obstet Gynecol 104:957-964, 2004.
3. Van Regemorter N, Dodion J, Druart C, Hayez F, Vamos E, Flamant-Durand J et al. Congenital malformations in 10,000 consecutive births in a university hospital: need for genetic counseling and prenatal diagnosis. J Pediatr 104:386-390, 1984.
4. Li S, Moore CA, Li Z, Berry RJ, Gindler J, Hong S-X et al. A population-based birth defects surveillance system in the People's Republic of China. Paed Perinatal Epidem 17:287-293, 2003.
5. Holmes LB, Harvey EA, Coull BA, Huntington KB, Khoshbin S, Hayes AM, Ryan LM. The teratogenicity of anticonvulsant drugs. N Engl J Med 344:1132-1138, 2001.
6. Lin AR, Herring AM, Amstatz KS, Westgate M-N, Lacro RV, Al-Jufan M et al. Cardiovascular malformations: changes in prevalence and birth status, 1972 – 1990. Am J Med Genet 84:102-110, 1999.
7. Carey JC, Feldkamp M, Herrick J, Byrne J. An etiologic classification of congenital malformations, including orofacial cleft in Utah. Proc Greenwood Genetics Ctr 23. 2004.

VII. NEW BALLARD REFERENCES

1. Kline J, Stein Z, Susser M. Conception to birth: epidemiology of prenatal development. Monographs in epidemiology and biostatistics, vol 14. New York: Oxford University Press, 1989.
2. Phelps DL, Brown DR, Tung B, et al. 28-day surviva] rates of 6676 neonates with birth weights of 1250 grams or less. Pediatrics 1991;87:7-17.
3. Ballard JL, Novak KK, Driver MA. A simplified score for assessment of fetal maturation of newly born infants. J Pediatrics 1979;95:769-74.
4. Sasidharan K, Dutta S, Narang A. Validity of New Ballard Score till 7th day of postnatal life in moderately preterm neonates. Arch Dis Child. 2008 Mar 12.
5. Streeter GL. Weight, sitting height, head size, foot length, and menstrual age of the human embryo. Contributions to Embryology I920;11:143-70.
6. Hern WM. Correlation of fetal age and measurements between 10 and 26 weeks of gestation. Obstet Gyneeol 1984;63:26- 32.
7. Pearson AA. The development of the eyelids. I. External features. J Anat 1980;130:33-42.
8. Constantine NA, Kraemer HC, Kendall-Tackett KA, Bennett FC, Tyson JE, Gross RT. Use of physical and neurologic observations in assessment of gestational age in low birth weight infants. J Pediatrics 1987;110:921-8.
9. Alexander GR, Hulsey TC, Smeriglio VL, Comfort M, Lenkoff A. Factors influencing the relationship between a newborn assessment of gestational maturity and the gestational age interval. Paediatr Perinat Epidemiol 1990;4:133-46.
10. Usher R, McLean F. Intrauterine growth of live-born Caucasian infants at sea level: standards obtained from measurements in 7 dimensions of infants born between 25 and 44 weeks of gestation. J Pediatrics 1969;74:901-10.
11. Horwood SP, Boyle MH, Torrence GW, Sinclair JC. Mortality and morbidity of 500- to 1499-gram birth weight infants live-born to residents of a defined geographic region before and after neonatal intensive care. Pediatrics 1982;69:613-20.
12. Hack M, Fanaroff AA. Changes in the delivery room care of extremely small infant (<750 gm): effects on morbidity and mortality. N Engl J Med 1983;308:1330,6.
13. Seel EJ. Outcome of very very low birth weight infants. Clin Perinatol 1986;13:451-9.

VIII. APPENDIX

IX. TRAINING LOG

Staff member name: _____

Observation of a trained examiner	**Signature of the examiner**
Observation 1: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Observation 2: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Observation 3: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____

Examination with a trained observer	**Signature of the examiner**
Examination 1: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Examination 2: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Examination 3: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Examination 4: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Examination 5: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Examination 6: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Examination 7: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Examination 8: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Examination 9: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Examination 10: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____

Approved to do examinations alone once 3 observations and 10 examinations have been completed.

Re-check 1: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Re-check 2: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____
Re-check 3: Date: |__|__|/|__|__|/|__|__| dd/mm/yy	_____