11 General Care of the Newborn

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Care of the Newborn

Whoever says "all newborns look alike" has not been in a nursery for more than a few minutes. Each newborn has their unique physical features and personalities from day 1. A few things are common to newborns of all types, shapes, and sizes but there are a lot of natural variations and findings of interest. This chapter will attempt to serve as a guide in the general medical care of these young patients.

Newborn History

Care of the newborn starts in the form of a complete history and physical. However, the newborn's history is really one of the mother's and the pregnancy. Even in the developed world, obtaining this accurate history can be complicated by the inconsistent transmission of data from the chart of one patient (the mother) in the outpatient setting to that of another (the newborn) in the inpatient setting. But due diligence is necessary to fully assess the newborn and to provide effective preventative care.

Maternal History

Although covered elsewhere in this textbook, it is important to emphasize that there are many preexisting maternal conditions that may affect the fetus as well as the health and subsequent management of the newborn. Some notable maternal conditions that the pediatrician should be aware of are breast disease (including any interventions that might interrupt lactogenesis), congenital heart disease, diabetes mellitus, developmental hip dysplasia (DDH – increases risk of DDH in newborn), fatty liver disease (associated with long-chain acyl-CoA dehydrogenase deficiency (LCAD) in newborns), genetic/heritable disorders, hypertension, infections (such as malaria and tuberculosis), mental health, polycystic ovary syndrome, autoimmune diseases (i.e., systemic lupus erythematosus where the newborn should be screened with and EKG for heart block), substance use (including tobacco and caffeine), social concerns, and thyroid disease (both hyper- and hypothyroidism).

A detailed history of the pregnancy is necessary for caring for the newborn. Key elements include: (1) medications, tobacco, alcohol, and illicit drug use during pregnancy, (2) medical conditions during the pregnancy including diabetes mellitus, pregnancy-induced hypertension or preeclampsia, (3) duration of the rupture of fetal membranes, (4) analgesics or anesthetics administered during labor, (5) infections or illnesses (keeping in mind geographically specific risks such as malaria), (6) mental health, especially anxiety and depression, and (7) compliance with care. The history of previous pregnancies, including miscarriages, previous child with congenital heart disease or neonatal illness, such as group B strep (GBS) sepsis or severe jaundice, also provides important clues. The pediatric care provider needs to obtain the results of maternal screening obtained during the pregnancy as recommended by organizations such as the American College of Obstetrics and Gynecology (ACOG). Key elements that should be obtained and clearly documented in the newborn's, record for every pregnancy include the items listed in *Table 11.1*.

The results from any prenatal ultrasonography should be obtained as these help in confirming gestational age, assessing the risk for conditions such as Trisomy 21, spinal dysraphisms, and with some notable exceptions, congenital heart disease. One ultrasound finding worth discussing in detail is that of fetal renal hydronephrosis. Many cases of fetal hydronephrosis will spontaneously resolve during the pregnancy. There is some small uncertainty in the exact measurement that should raise pediatric concern but 15 mm is concerning for blockage and most would agree that those with a diameter >8 mm warrant follow-up. Certainly, any cases with associated oligohydramnios should be evaluated. Additionally, males with bilateral involvement warrant postnatal renal ultrasonography in the birth hospital stay to rule out vesicoureteral reflux or posterior urethral valves. However, due to the relative dehydration of newborns, even negative postnatal screening should be repeated at 3–4 weeks. Antibiotic prophylaxis is indicated for those with evidence of bilateral involvement in utero, abnormal renal

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Table 11.1
Maternal screening

Blood type and antibody screening	Rubella
Syphilis (RPR repeated in third trimester based on epidemiological prevalence)	Hepatitis B surface antigen
HIV (1 & 2)	TB (PPD)
Diabetes screening	GC and CT for high risk pregnancy
Urinalysis (especially if GBS positive)	GBS (rectovaginal screening within the last 5 weeks)
Domestic violence	Serum lead level (if high-risk category)

architecture, collecting system dilatation, documented reflux, or hydronephrosis on postnatal ultrasound. Due to the high concentration of the drug and general susceptibility patterns, prophylaxis with Amoxicillin suspension (20–25 mg/kg, PO, once a day) is effective and well tolerated. Surgical consultation with a pediatric urologist should also be obtained to help coordinate ongoing assessment. Antibiotic prophylaxis should continue until repeat imagining is obtained at 3–4 weeks, including a VCUG when indicated.

Maternal medications and the consumption of other substances need to be reviewed by the pediatric provider as some may cause problems in the newborn. Antihypertensive medications may cause hypoglycemia in the newborn. Serotonin uptake inhibitors, tobacco, caffeine, and opiate containing narcotics either prescribed or otherwise, may cause toxicity or withdrawal symptoms in the newborn (which is discussed in detail in Chap. 34, "Miscellaneous Disorders").

Gestational Age

The physical examination of the newborn starts with the assessment of gestational age and in utero growth. In industrialized countries, most pregnancies currently have accurate dating through confirmation of gestational age with prenatal ultrasound. As a general rule, determinations from the first trimester are accurate to within ±1 week, those in the second trimester within 2 weeks, and third trimester within 3 weeks. However, second and third trimester dating by ultrasound may substantially underestimate true gestational age in the presence of abnormal fetal growth. Additionally, prenatal gestational age estimates can be confirmed with the use of the New Ballard score (see Web site listed in the Resources). With the trained examiner, this scale has been shown to have good reliability and validity. With the best estimate of gestational age, the clinician can then plot the birth weight, the head circumference, and the length on a standardized graph to evaluate fetal growth.

Growth Assessment

In September 2010, the Center for Disease Control and Prevention (CDC) published a recommendation that from birth to 24-month age groups, all clinicians should use the 2006 World Health Organization (WHO) graphs. The WHO charts were designed as a reference (goal) growth curves within breastfeeding populations from a sampling of countries (Brazil, Ghana, India, Oman, and the USA). The clinician, when interpreting the growth of infants who are formula fed should be aware that breastfed babies do gain more weight in the first 2–3 months, and then stabilize or slow down thereafter. These graphs are available on the organization's Web site with links in the reference section. Although the WHO is an international reference, clinicians may choose to use normative graphs developed within their own country, as there may be ethnic and demographic differences – though these were surprisingly small in the diverse population included in the WHO study. Preterm and late preterm infants (those with completed gestational age of 34^{+0}–36^{+6} weeks) are best plotted on the Fenton graph, until 50 weeks of corrected age. There are also condition-specific growth charts for infants with diagnoses such as Trisomy 21 and Turner's syndrome.

Newborns are categorized as either appropriate for gestational age (AGA), small for gestational age (SGA), or large for gestational age (LGA) based on their percentiles. Classically defined, SGA is below the 10th and LGA as above the 90th percentiles. However, more recent cutoffs are using either the 5th/95th or 3rd/97th percentiles as these approach the two standard deviations used to define abnormal versus normal distributions, or those constitutionally small or large. Some have also suggested that customizable birth weight centiles would help to distinguish between those whose weight is constitutional from those at risk from pathologic SGA or LGA. Traditionally, SGA infants were also divided based on whether the growth restriction has been symmetric or asymmetric with sparing of the head circumference. In an attempt to better understand the significance of being SGA, researches looked at the mortality and morbidity rates in

a large US population-based sample for those SGA at preterm versus term birth. They found higher rates of mortality and morbidity for all preterm births and a greater adjusted relative risk in relation to SGA at term than preterm. However, they also found that the adjusted excess mortality risk from SGA declined until term with a plateau after 37 weeks. Both SGA and LGA status has inherent risks that need to be addressed and are fully discussed in a subsequent chapter (see Chap. 13, "The High-Risk Infant").

Newborn Physical Examination

For all newborns, the examination should start with a general observation of the state (sleeping, awake and quiet, awake and stirring, or crying), color (pink, acrocyanosis, perioral cyanosis, or central cyanosis), and pattern or work of breathing (e.g., grunting, flaring, retractions). From there, generally the best approach to examining the newborn is to keep them warm and let them lead the sequence of the exam. This means that if they are quiet, one starts with auscultation of the heart and lungs and palpation of the femoral pulses (crying makes these small pulses a moving target). But if they are crying or unsettled, then it is best to start with other parts and work on consoling them. But wherever one starts, it is best to continue the examination in your set sequence so not to miss critical parts when you are interrupted with crying or regular newborn care. Included in *Table 11.2* is a description of an approach to complete examination of the newborn. The next section of this chapter will highlight normal findings or variants found in newborns.

Skin

Through the course of sequentially unwrapping part of the newborn, the examiner will eventually get to visualize the entire skin surface of the newborn for rashes and other lesions. Common skin findings unique to the newborn are discussed below:

Erythema toxicum: This very common rash occurs in almost 50% of newborns. These transient flesh-colored to whitish papules on erythematous macules that appear over the first few days (with about two thirds occurring between 24 and 48 h of life) spread with individual lesions that come and go, and then resolve spontaneously. These can appear in any distribution and commonly coalesce on the face, abdomen, and back. These papules have no known cause but are very common and contain

Table 11.2
Key elements of newborn exam

General	*Abdomen*
• Wash hands prior to examining infant • Keep infant warm when examining (under warmer, blankets) • Support head/neck when moving infant • Assess maturity appropriately (term, preterm) • Assess intrauterine growth appropriately (AGA, SGA, LGA)	• Palpate for liver, spleen, kidneys, masses • Examine umbilicus visually; palpate for umbilical hernia
Order of exam	*GU*
• Auscultate heart and lungs while infant calm	• Boy: Examine penis for hypospadias; Palpate testes (undescended, hernia, hydrocele) • Girl: Examine hymen visually, labia
General appearance	*Anus*
• Note general appearance, distress, color, tone, spontaneous motor activity	• Visual check for patency • Visual assessment of placement of anus, measure if concerns
Skin	*Back*
• Examine skin; note birthmarks, jaundice, rashes if present	• Look for scoliosis, sacral dimple, or sinus tract
HEENT	*Extremities*
• Palpate fontanel (anterior, posterior), sutures, measure if concerns • Examine for cephalohematoma, caput • Check red-reflex • Examine pinnae: position, preauricular pits or tags • Check for septal dislocation or choanal atresia • Check for cleft palate (visually back to uvula and palpation)	• Palpate for femoral pulses • Examine hands/feet (creases, symmetrical size) • Examine gluteal and thigh folds for symmetry • Barlow/Ortolani tests
Chest	*Neuro*
• Palpate clavicles smoothness and symmetry • Auscultate heart • Auscultate lungs, work of breathing	• Root, suck, palmar grasp, cry • Examine for symmetric Moro

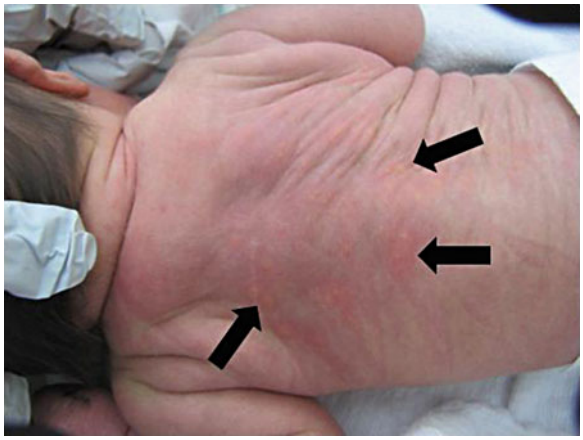

Figure 11.1
Erythema toxicum coalescing on the back of a 2-day-old newborn infant (Photograph by Cindy Klipfel, MD)

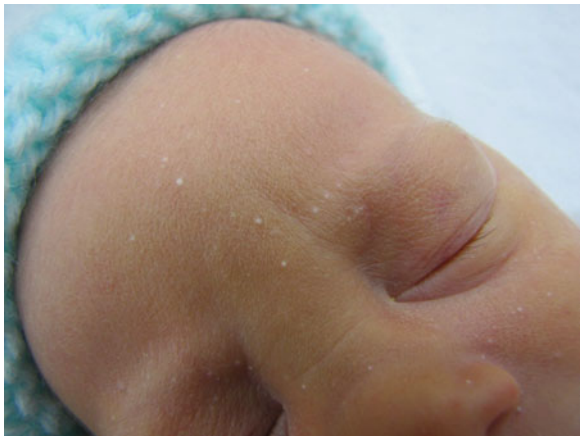

Figure 11.2
Classic scattered milia on a 2-day-old newborn (Photograph by Marcia W. Van Vleet, MD, MPH)

eosinophils, which suggest the involvement of a histamine pathway and as such might be a response to the general stress of delivery. The only rare potential complication of erythema toxicum is secondary infection (Fig. 11.1).

Harlequin change: This distinctive and well-demarcated color change is only seen in newborns and is a transient hemi color change with erythema on one half of the body and pallor on the other. It presents in the first few 2–5 days of life in approximately 10% of healthy newborns (although some have linked it to low birth weight, hypoxia, intracranial injury, prematurity, or use of prostaglandins). It may persist for 30 s to 20 min and has no long-term sequelae.

Milia: These are present at birth as white papules without erythema commonly occur on the face of up to 50% of newborns. They are inclusion cysts of sebaceous material with similar etiology to the Epstein pearls on the palate, Bohn nodules on the gingival ridge, and other inclusion cysts on any other midline structure including the foreskin of the penis. Milia can be seen on newborns born in any season but might have a slightly increased prevalence in the warmer months (summer in the northern hemisphere). Parent should be advised that these are not pimples and should not be squeezed but left alone. Of note, there are smaller sebaceous inclusion cysts that occur more frequently usually on the nose that are commonly although perhaps mistakenly called "milia" as well. Both "milia" lesions are self-limited and are reabsorbed by the body by 3 months of age (Fig. 11.2).

Neonatal acne: This is a relatively common transient form of the common teenage affliction that occurs in about 20% of infants and usually appears about 3 weeks after birth, although it rarely can be present at birth. It usually appears on the face, mainly on the cheeks, forehead, and chin as erythematous papules and pustules, or as white closed comedones. It is thought to be caused by transplacental passage of the mother's hormones and the newborn's own androgens. Male babies are more prone than females and spontaneous resolution is the rule. There is another form of acne that occurs after 3 months of age which is usually called infantile acne and seems to have a different etiology and is likely multifactorial, similar to the adolescent form.

Sucking blister: Occurring as the result of the fetus sucking in utero, these are apparent at birth. As such, their oval to circular shape and distribution on the dorsum of the hands, wrists, and forearms is characteristic. They may be fluctuant bullae that can be fairly large (up to 1.5 cm) which then quickly evolve to reveal a superficial erosion. There is a notable lack of other blisters, vesicles, or marked erythema that would otherwise suggest other etiologies. The residual hyperpigmentation or scaring heals on its own relatively quickly (Fig. 11.3).

Transient neonatal pustular melanosis (TNPM): These are small superficial white pustules on a non-erythematous base that easily unroof to reveal superficial, well-circumscribed scales and subsequent melanotic macules. Frequently, the pustules will be unroofed in utero or in bathing so only scales and freckling is observed on the initial exam. These can be frequently observed on the face, neck, abdomen, and lower back/sacrum. They also occur more frequently in those with darker skin coloring including Asian and African infants, with an overall incidence of

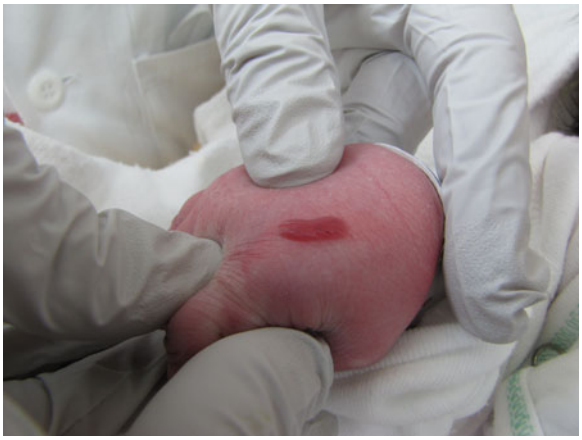

Figure 11.3
Characteristic appearance, shape, and distribution of a sucking blister seen on a newborn's initial examination (Photograph by Cindy Klipfel, MD)

0.2–4.4%. To confirm the diagnosis, it is best to observe lesions in all three forms (pustule, scale, freckle), but if gram stain were to be obtained, it would demonstrate neutrophils. Differential diagnosis of TNPM includes staphylococcal infection (usually erythematous and yellowish pustules), and herpes simplex virus (multiple forms classically with an erythematous base and clear vesicles that may cluster). It is very important in newborns to keep HSV in the differential diagnosis for any unknown rash as there are serious consequences if not treated immediately (discussed in detail in Chap. 27, "Neonatal infections").

Jaundice: This yellowish appearance to the skin and sclerae is very common in newborns and represents hyperbilirubinema, primarily due to physiologic increase in hematocrit of the newborn with shorter lifespan of neonatal erythrocytes and the slower/delayed conjugation in the newborn's liver. Most newborns, up to 60% of full term and 80% of preterm, will develop some degree of visible jaundice with most peaking in the first 3–4 days. For those born prematurely and those with extensive bruising or cephalohematomas, the maximal intensity may occur closer to 5–7 days of life. Although many newborns develop jaundice, its appearance in the first 24 h of life is pathological in nearly all cases. Jaundice generally moves from a cephalad to caudal progression and has historically been correlated to serum bilirubin levels with the loose rule of "Head= 5 mg/dL, chest =10 mg/dL, umbilicus=15 mg/dL" adapted from Kramer. Multiple studies have subsequently demonstrated; (1) a lack of agreement between examiners (at every level of training) and serum bilirubin levels, and (2) a very good negative predictive value for visual inspection (meaning no visual jaundice is predictive of not developing significant hyperbilirubinemia). Keren et al. recently found a negative predictive value of 98.6% for the complete absence of jaundice and the subsequent development of significant hyperbilirubinemia, defined as within 1 mg/dL of requiring phototherapy by the American Academy of Pediatrics (AAP) recommendations.

Birth marks: These should be described in quality and distribution in the newborn's documentation. Most are beyond the scope of this chapter/text but a few with unique characteristics in the newborn will be discussed.

Capillary hemangiomas: Although these are easy to diagnose later in infancy when they develop thickening, they can either not be apparent or have a subtle appearance that is difficult to diagnose in the newborn. When they are present in the newborn they can appear as a nondescript, slightly erythematous blanching macule or a spider like telangiectasia with irregular boarder and can frequently have a surrounding "halo" or blanching. Clinical course is sufficient for the diagnosis and management of most of these lesions. However, those over key organs such as the liver, spleen or spine, and when three or more appear on a patient warrant ultrasound investigation, as they may have deeper vascular connections. Capillary hemangiomas will progress over the first 6–12 months of life, and then will regress with 50% resolving by 5, and 90% by 9 years of age. Most need no intervention; however some will depending on location, such as if they interfere with binocular vision, obstruct airway or breathing, or lie over the liver, spleen or spine. Although a rare occurrence those lesions over the liver or spleen with vascular connections can become significant reservoirs potentially causing fluid shifts, and clinical instability. The development of large lesions can also rarely cause a Kasabach–Merritt syndrome with rapid platelet consumption and DIC (*Fig. 11.4*).

Nevus flammeus (aka Nevus Simplex, salmon patch): These erythematous macules with irregular boarders occur on the forehead, eyelids, glabella, nose ("Angel Kisses"), and most commonly on the nape of the neck ("Stork Bite"). They cross the midline and blanche, but otherwise can be difficult at times to differentiate in the newborn from more serious lesions such port wine stains which are usually unilateral. Those lesions that occur unilateral in the distribution of trigeminal nerve first branch (cranial nerve V1) covering the lateral canthus of the eye should be evaluated by ophthalmology and MRI imaging at 6 months of age to evaluate for the potential

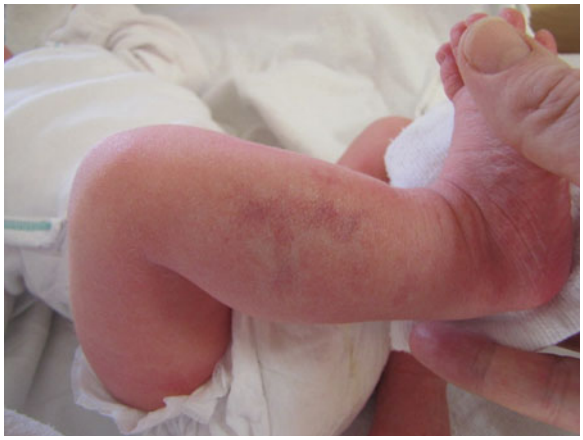

Figure 11.4
Although most are not apparent on the newborn, this capillary hemangioma found at birth on a newborn's leg is characteristic for its blanching central purplish macule or telangiectasia with surrounding hypopigmentation or halo. Upon questioning, the mother also had a capillary hemangioma that spontaneously resolved by 5 years of age (Photograph by Cindy Klipfel, MD)

Figure 11.5
Nevus flammeus or simplex in the classic "Angel Kiss" distribution in the midline of the forehead. Although slightly less visible on this photograph, the patient also had one just under the nose on the upper lip (Photograph by Cindy Klipfel, MD)

for Sturge Weber syndrome. Clinical course of nevus flammeus or simplex is equally distributed in three groups: those that essentially remain the same, those that lighten, and those that totally disappear (*Fig. 11.5*).

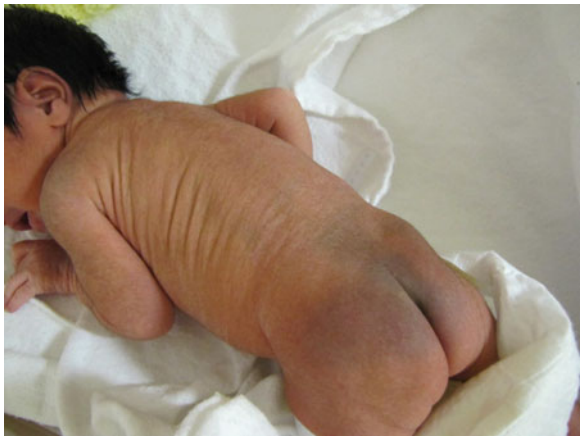

Figure 11.6
Newborn with characteristic distribution of a dermal melanocytosis over the lower back and sacrum, as well as one on the left shoulder (Photograph by Marcia W. Van Vleet, MD, MPH)

Dermal melanosis: These melanotic lesions commonly with irregular borders and pigmentation that can vary from brown, blue-gray, to blue-black. Previously called "Mongolian spots" these can occur in any location they are commonly found on the back, sacrum, arms and legs. They can be found on any newborn but occur more commonly in those with more melanin or darker skin (up to 80% of African and Asian newborns). They can even appear even slightly more bluish in parts and might be confused with a blue nevus. Many will fade in adulthood but some may not totally disappear. There is otherwise no specific management or treatment necessary for these benign lesions except to monitor for changes (*Fig. 11.6*).

Head and Neck

Careful inspection of the head and neck of the newborn includes observation for shape and palpation of normal structures such as the sutures, anterior and posterior fontanels, as well as any abnormal bony prominences. Molding and overriding sutures are common, but should be documented to help interpret changes in head circumference. Molding, which generally resolves in 3–5 days is the result of compression of the head in utero either from being engaged in the pelvis or from passage through the birth canal. Overriding sutures are also due to similar causes and should resolve in 2–3 weeks with the expansion of normal growth of the brain. Palpation of the

sutures can also reveal craniotabes or a sensation of a "ping-pong" which is usually a normal variant in the newborn especially those born at lower gestational ages. These usually resolve with the natural ossification of bones, but if delayed should raise suspicion for alterations in ossification.

Fontanels and suture lines: These should be palpated and their size assessed (see *Fig. 11.7*). Sagittal sutures can be open with a normal gap of up to ½ cm. Midway along the sagittal suture a third fontanel exists in 6.3% of newborns, with a higher percentage found in those with Trisomy 21 or congenital rubella. The normal metopic suture also can be open, however when extremely large or deep can be suggestive of delayed ossification, including hypothyroidism. The anterior fontanel should be palpated for firmness, bulging, or depression with the newborn's head elevated to 30°. The fontanels can be measured by finding the mean of the distances of the axis, as shown in *Fig. 11.7*. This measurement may increase slightly in the newborn period as the molding and overriding sutures resolve. In the USA, the average size of the anterior fontanel at birth is 2.1 cm (range 0.6–3.6 cm). This statistic varies in ethnic groups with African Americans reported as slightly larger with average 3.6 cm (range 1.4–4.7 cm) and a reported mean in a sample from India of 3.37 cm (range 2.2–4.5 cm). Posterior fontanel averages 0.5 cm in size but also has ethnic differences (Black/African American reported average also slightly larger at 0.7 cm). These differences may either be related to constitutional differences or may be an effect of nutritional status. The fontanels then close over the course of the next 1½–2 years with the posterior closing first (average of 2 months) and the anterior closing at an average of 13.8 months (reported as 9–24 months), with the study from India finding that 50% had closed sometime between the 12 and 15 month exams (91.3% closed at 2 years).

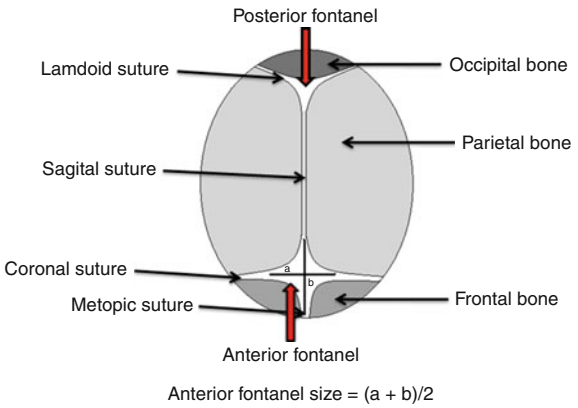

Figure 11.7
Schematic of newborn skull facing examiner (as seen from above). Note the demonstration of how to measure fontanel size as the average of the anterior–posterior and transverse diameters (Drawn by Marcia W. Van Vleet, MD, MPH [Adapted from Kiesler])

Ears: Complete examination of the newborn's ears includes visual inspection of the position, size, and external structures. With an otoscope internally visualize for the presence of a gray-white tympanic membrane. It will not be possible (due to small anatomy and likely obstruction by vernix) to distinguish the internal landmarks, but visualization is just to confirm the existence of the canal.

Eyes: The placement, position, spacing of the eyes, and size of the opening of the eyelids should be inspected visually. Normal palpebral fissure length in the newborn is over 5 mm. Rarely, the intercanthal distance may appear wide on the newborn due to a dacryocystocele. Although it might not be apparent on the first few days of life, the dacryocystocele classically presents with a bluish nodule palpable between the nose and inner canthus. Commonly, inspection of the eyes during the first few days is obscured by eyelid edema. Ideally, the eyes would be observed simultaneously for pupil symmetry and the red reflex. However, this is usually not possible in the newborn. The red reflex should be observed for any defects as well as white appearance suggestive of congenital glaucoma or retinal masses. In darker skinned newborns, the red reflex might be difficult to appreciate but should be visible in a dark room and may appear silvery in color. Visualization of the retinal vessels may be helpful in determining the presence of a red reflex. The eyes should be inspected for signs of infection (erythema, swelling, conjunctival injection, and purulent discharge). Please refer to the section below on the management of eye discharge.

Nose: The nose should be inspected for general symmetry or dislocation of the septum. Patency could be confirmed with movement of a thin tissue or cotton ball wisp under each nare while the contralateral nare is obstructed and newborn is sucking.

Mouth: It is important to visualize the newborn's mouth including the gums, the frenulum (both lingual and labial), the soft and hard palates and all the way back to the uvula. Having the newborn suck on the examiner's finger helps in assessing the pattern of tongue movements (milking front to back) and for how far the newborn is able to extend the tongue. Minimally, this would be past the gums, but ideally past the lips for optimal breastfeeding. Additionally, the hard and soft palate should be palpated to detect any submucosal clefts which

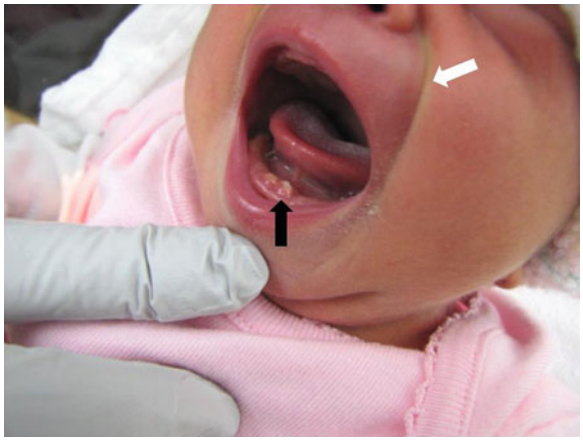

Figure 11.8
Newborn with two natal teeth found on the discharge exam. Note also the jaundice visible in the nasolabial folds when crying (Photograph by Cindy Klipfel, MD)

would not be detected on direct visualization alone. Absence of the uvula or a bifid uvula would also suggest a palate cleft. Common findings in the mouth include Epstein pearls (midline on hard palate), Bohn nodules (on gingivae), epulis, ranula, and neonatal teeth (*Fig. 11.8*).

Neck: The neck of the newborn should be inspected and palpated for tracheal deviation, and any masses (it is common to feel hyoid bone on newborns). Depending on their exact location, midline masses may represent thyromegaly or thyroglossal duct cysts, and those just anterior to the sternocleidomastoid muscle being brachial cleft (I, II, III) cysts or nodules.

Thorax

Examination of the thorax starts with auscultation of the heart and lungs. This can be done underneath the shirt so as to limit disruption of the calm newborn. Murmurs are very common in the first 24 h of life (up to 80%) and are discussed later in the chapter. Palpation of the point of maximal impulse is also important to help in the diagnosis of dextrocardia and hyperdynamic states (common during transitioning). Inspect the breathing pattern, shape (barrel, pectus, etc.), and symmetry of the chest. Palpate clavicles from sternal notch to acromion for continuity, smoothness, tenderness, and especially symmetry between to two sides. In the newborn period, the most sensitive presenting sign of a clavicular fracture is asymmetry and not the classic step off or crepitus (please refer to the Chap. 12, "Birth-Related Injury" for more details). Both males and females can have gynecomastia and possibly even milk discharge (a.k.a. "witches milk") from exposure to maternal estrogen in utero. Stimulation from palpation should be limited; however, other masses and mastitis can rarely occur.

Abdomen

Again examination starts with auscultation, this time for the presence of bowel sounds. Next, palpate for the size and texture of the liver, spleen, kidneys, and for the existence of any other masses. Visually inspect the umbilical cord for number of vessels, any erythema, swelling, or discharge. Variants to the umbilical cord include Wharton's jelly/umbilical hematoma (which can be fatal in utero but is of little significance in an otherwise stable newborn). Examination of the umbilical cord also includes palpation for abdominal contents and the base for any defects or bulging through the fascia consistent with an omphalocele or umbilical hernia.

Extremities

Examination of the lower extremities includes simultaneous palpation of the femoral pulses. The absence or asymmetry of the pulses would require immediate evaluation for coarctation of the aorta. However, in the newborn period, the pulses may exist even with a coarctation during the period of cardiovascular transition while the ductus arteriosus is open. Assess for symmetry of the major folds, knee height, leg length, and size of feet. Serial examinations of the newborn's hips are essential. Specifically, the Barlow (dislocation/subluxation) and Ortolani (reduction) tests should be performed to assess for hip stability. Commonly in the newborn, clicks or ligamentous laxity is felt without subluxation of the joint. Any actual movement of the hip greater than 5 mm or joint subluxation should be referred to orthopedics for placement in a Pavlik harness. Imaging in the newborn period is not necessary, but ultrasounds at 4–6 weeks of life may help to further assess those at increased risk (such as breech females and breech males with a family history) or the inconclusive exam. Orthopedics will follow serial hip ultrasounds to assess the progress of treatment. After about 6 months of age, MRI becomes the image of choice. Subluxation of other joints should also be referred to orthopedics for treatment and may be associated with certain syndromes. Grasp of all four

Figure 11.9
Newborn with postaxial polydactyly, on a thin pedicle with a nail (Photograph by Cindy Klipfel, MD)

extremities is important to assess both for neurological changes but also for general strength. Digits should be counted on both hands and feet. Although linked with many syndromes, syndactyly of the feet and polydactyly of the fingers, commonly occur in normal families. Thin-stalked supernumerary digits could be tied off by the pediatrician. When performed correctly (sufficiently tight and flush with the adjacent skin), the digit will drop off in several days, leaving no remnant. Creases of the hands and feet are important to assess as these may reflect in utero movements or conditions such as Trisomy 21 (non-pathognomonic single transverse palmar creases and prominent vertical crease on the foot) and fetal alcohol syndrome (hockey stick palmar crease) (*Fig. 11.9*).

Genitourinary (GU) System

External inspection of the female and male genitourinary system is important. For the female, this would include the clitoral hood, labia majora/minora, and the hymen. Frequently a newborn female will have milky white vaginal discharge, hymenal/vaginal tags, and possibly even serosanguinous vaginal discharge, all believed to be due to exposure to the mother's hormones (estrogen effects). Examination of male genitalia includes palpation of the testes. At least one of the testicles should be palpable in the scrotal sac. The absence of both should be investigated as soon as possible with ultrasonography. The penis should be examined for length (normal greater than 2 cm stretched on the full-term newborn), for chordee (curvature when erect), for penoscrotal web (a common form of chordee), for the course of the raphae, and for the location of the meatus. The raphae may be tortuous but should end near the 6 o'clock position. Raphae that do not should raise the examiner's diligence in looking for other GU findings as these rarely can be associated with hypospadias and torsion of the glans. The meatus should be midline central on the glans and no more than 5 mm in length. Longer length is suggestive of megameatus. Minor variations in the position of the meatus is normal; however, any that approach the edge of the glans or with other GU findings should be referred for urologic evaluation before circumcision. Frank hypospadias or epispadias are definite contraindications for circumcision. Ambiguous genitalia appear as a spectrum best summarized by Prader staging. However, the newborn physician should be aware that ambiguity of the genitalia has large social ramifications for the families.

Anus

Visual inspection of the anus and its position is important. Roughly, the anus should be about halfway between the scrotum or vaginal opening and the coccyx. The normal position of the anus has been described as the anal position index (API), or the ratio of the distance from anus to fourchette/scrotum to the total distance from the coccyx to fourchette/scrotum. In male newborns, this is a mean of 0.54 (95% CI 0.53–0.55) and in females it might be slightly anterior to this at about 0.45 (95% CI 0.44–0.46). Ratios less than the 95% CI warrant further investigation. Internal exam of the anus/rectum is not routinely necessary. Current recommendations that newborn screening temperatures be taken in the axilla (during the birth hospital stay) means that the physician needs to do careful inspection of the anus as the nurses may not detect cases of imperforate anus they would have with rectal temperatures (*Fig. 11.10*).

Back/spine

It is imperative to visually inspect a newborn's spine from head to sacrum for dimples, curvature (scoliosis), or masses. Simple dimples (<5 mm and superficial with visible base) in the intergluteal fold are very common. In the case of normal lower extremity tone and neurological exam, these do not warrant imaging. However, dimples that occur outside of the gluteal crease (more than 2.5 cm from the anus), or have any associated skin changes including tufts of hair, should be evaluated with an ultrasound in the first few weeks of life to rule out a tethered

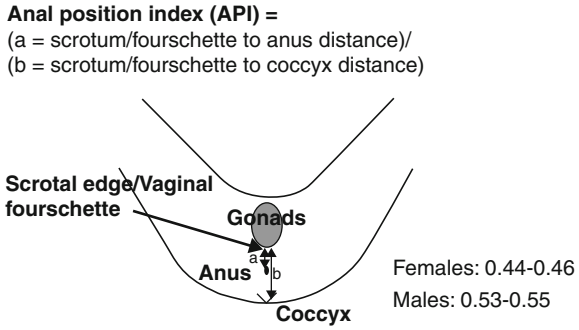

Figure 11.10
Schematic of how to measure the anal position index (API) (Drawn by Marcia W. Van Vleet, MD, MPH [Adapted from Davari])

cord. Any open spinal defects or neurological changes warrant immediate evaluation.

Neurobehavioral

The examination of the newborn needs to include a careful assessment of the general state, tone, posture, and reflexes. All newborns should have certain innate reflexes independent of gestational age. These reflexes include suck, moro, root, grasp of hands and feet, stepping, gallant, fencing, and deep tendon reflexes. At rest, the late preterm infant will have some flexion of their extremities, while full-term infants are more relaxed and extended when calm. Tone should be examined when the newborn is at rest, upright, and prone over the examiner's palm. The newborn when prone should not be either "stiff as a board, nor as floppy as a scarf." Preterm and even those late preterm infants will have subtle differences in their tone and magnitude of reaction to stimuli. But again, hypotonia and the absence of reactions to stimuli are abnormal at any gestational age. Newborns should show good state variability, by being able to go from sleep, to awake with cry, and back to calm during the exam. Poor state variability and "shutting down" are signs that the newborn is stressed. These stressed infants, as well as any found not to have intact reflexes, require immediate full evaluation including laboratory assessment looking for the existence of sepsis/meningitis and imaging of the central nervous system.

Newborn Screening

Primary screening in the newborn is very important to detect disease before irreversible damage or mortality. Some of these recommended screens are disease- or condition-specific (e.g., glucose screening for those SGA, LGA, or infants of diabetic mothers), and others are universal (e.g., hearing screening and metabolic newborn screening panels).

Glucose: It is recommended that newborns with risk factors for hypoglycemia such as those SGA, LGA, infants of diabetic mothers (IDM), IUGR, premature, evidence of perinatal stress or failure to adapt, and any with symptoms of hypoglycemia undergo routine glucose screening. Symptoms associated with hypoglycemia in the newborn include change in mental status (irritability, lethargy, stupor), poor feeding especially after feeding well, jitteriness or tremors, hypothermia, cyanotic spells or apnea, hypotonia, seizures, or coma. Screening can be done quickly and easily at the bedside with an appropriate whole blood point of care testing device. Not all such devices correlate well at lower glucose levels (some even at or below 55 mg/dL). Levels determined to require intervention should be confirmed by serum glucose analysis before but without delaying the first intervention. Variation in nursery protocols for the frequency of testing and the interpretation of results exist, as the evidence is not universally clear on the definition of hypoglycemia in the newborn. As summarized by Cornblath, the classic diagnosis of hypoglycemia in a newborn needs to meet Whipple's triad of (1) presence of characteristic clinical manifestations, (2) coincident with low plasma glucose level, and (3) resolution of the clinical symptoms once normoglycemia is established. However, it is probably that otherwise well, asymptomatic full-term newborns may tolerate glucose levels much lower than adults, questionably lower than preterm newborns, and perhaps below those previously suggested without adverse outcomes. What can be universally accepted is that newborns: (1) with hypoglycemia may present with a wide variety of nondescript symptoms or may be totally asymptomatic, (2) that any newborn with symptoms consistent with hypoglycemia should be treated more aggressively than those without, (3) that really low levels (less than $<$20–25 mg/dL (1.1–1.4 mmol/L)) require immediate correction with IV dextrose (please refer to Chap. for the IV management of hypoglycemia), (4) that prolonged hypoglycemia is probably worse than isolated events, and lastly (5) once hypoglycemia requiring intervention (cutoff is debatable but Cornblath suggests $<$36 mg/dL (2.0 mmol/L)) is documented, it is important to intervene, test to make sure that your intervention has worked ($>$45 mg/dL or 2.5 mmol/L), and then repeat testing prior to subsequent feedings (every 2–3 h) to make sure the newborn does not become hypoglycemic

again. Most newborns when feeding well will stabilize their glucose levels by 18–24 h of age, so primary screening in asymptomatic newborns after this time period is not necessary. Newborns that develop or continue with hypoglycemia warrant investigation for causes including sepsis and metabolic conditions including hyperinsulinemia.

Hearing: Universal hearing screening is recommended during the birth hospital stay as permanent hearing loss has been reported in up to 2.2 per 1,000 live births. Additional screenings to detect delayed onset hearing loss or deficits are based on risk factors (such as hyperbilirubinemia, exposure to ototoxic medications, cranial facial anomalies and associated syndromes, in utero infections like CMV, and family history) (see *Table 11.3*). Generally hearing screening in the newborn nursery in absence of the aforementioned risk factors can occur with otoacoustic emission testing (OAE). Those with risk factors, or failure of the OAE should undergo screening with the auditory brain stem response (ABR) testing. Early universal hearing screening has been demonstrated to be effective in detecting disease, in providing amplification when necessary at an earlier age, and in preventing long-term speech and developmental delays (including better performance on measures of social development, gross motor skills, quality of life, and overall scores). The Joint Committee on Infant Hearing in the USA has set forth the following goals for hearing screening programs: (1) that all infants

Table 11.3
Risk factors or markers associated with hearing deficits

In utero/familial factors	Neonatal/perinatal factors	Postnatal factors
In utero infections: • CMV (5–61%) • Rubella (50–76%) • Syphilis • HSV • Toxoplasmosis	Birth weight: • <1,500 g (2–10%) • <800 g (20%)	Prolonged NICU stay >5 days Seizures or apnea spells
Maternal exposure to aminoglycosides	Low APGAR scores: • 1 min: 0–5 • 5 min: 0–6	Respiratory markers: • Mechanical ventilation • ECMO • Persistent pulmonary hypertension
Family history of hearing loss during childhood	Syndromes: • Alport • Branchio-Oto-Renal • Cornelia de Lange • Jervell/Lange-Nielsen • Pierre Robin • Treacher–Collins • Trisomy 21 • Usher • Waardenburg (white forelock)	Hyperbilirubinemia • Requiring exchange • >22 mg/dL in BW >2,000 g • >17 mg/dL in BW <2,000 g
	Cranial facial abnormalities • Cleft lip/palate	Bacterial infections: • Meningitis (up to 30%) • Sepsis
	Neurodegenerative disorders • Charcot–Marie–Tooth • Friedreich ataxia • Hunter syndrome • Neurofibromatosis type I	Exposure to ototoxic medications: • Gentamicin (>2 days) • Tobramycin • Furosemide (Lasix) • Chemotherapy
		Birth-related or postnatal injury • Facial nerve • Head

should be screened by 1 month of age, (2) infants who do not pass should undergo additional hearing testing by 3 months of age, and (3) that infants diagnosed with hearing loss or deafness should start early intervention as soon as possible but no later than 6 months of age.

Hyperbilirubinemia: The most recent recommendations from the AAP in 2004 include the development of systematic screening processes that include universal risk assessments, parental education, early bilirubin level determinations that can be initiated by nursing staff based on clinical appearance, encourage and support of breastfeeding, and close follow-up for reassessment in the 48–72 h after hospital discharge based on the preceding determinations. Many, including the Canadian Pediatric Society and other opinion statements from experts, have recommended that each newborn have a determination of their bilirubin level prior to discharge from the birth hospital. Multiple studies have investigated universal screening with either a serum or transcutaneous bilirubin level in conjunction with hour-specific levels or nomograms and have found them to be effective in preventing excessive levels of hyperbilirubinemia. However, it is difficult to document the effectiveness of these universal screening methods in reducing the rate of kernicterus, because of its low incidence. Transcutaneous levels (TcB) should be confirmed with a serum level (TSB). Maisels et al. suggest obtaining a TSB level when the TcB is 70% of the TSB level for phototherapy, is greater than the Bhutani nomogram's 75th percentile (discussed below), >95% on a TcB specific nomogram, or when the TcB is >13 mg/dL after discharge.

In order to interpret the serum result obtained, we need to know if the newborn has any risk factors for hyperbilirubinemia. The effectiveness of all screening programs depends on close clinical follow-up and awareness that up to 10% of newborns do not follow the course predicted by these nomograms (primarily the late preterm infants and those with hemolysis of any cause). One of the most important of these factors is gestational age (preterm at largest risk, but those less than 38 weeks are also at increased risk), because the preterm infant is more likely to have both delayed hepatic clearance as well as inadequate intake. Other risk factors to consider in interpreting a bilirubin level are conditions that would cause increased hemolysis. Note, however, that all causes of hemolysis in a newborn do not cause the DAT to be positive (in 8%), and that some with a positive DAT may not have clinically significant hemolysis. Also it is important to determine how well the newborn is feeding, as poor breastfeeding (and hence decreased stooling) will increase the newborn's risk of hyperbilirubinemia. Additional risk factors are found in *Table 11.4*.

Table 11.4
Risk factors for the development of severe hyperbilirubinemia

Major risk factors	Minor risk factors
• Predischarge TcB or TSB in high-risk zone[a]	• Predischarge TcB or TSB in intermediate risk zone
• Gestational age 34–35 weeks[a]	• Gestational age 36–37 weeks
• DAT+ or other known hemolysis[a]	
• Jaundiced before 24 h	• Jaundiced before discharge
• Exclusive breastfeeding (especially if not well or with excessive [8–10%] weight loss)	
• Sibling received phototherapy	• Sibling with jaundice
• Cephalohematoma or excessive bruising	• Macrosomic IDM
	• Maternal age ≥25 years old
• East Asian race	• Male gender[b]

Adapted from the AAP 2004 Guideline
[a]More recent studies have consistently shown predischarge TcB or TSB and GA are most significant predictors. In general these studies have not included patients with known hemolysis
[b]Unsure clinical significance, and not included in more recent studies

Once these risk factors or the lack thereof have been determined, it is best to interpret the level based on an hour-specific nomogram. Lease and Whalen have a very thorough assessment of the current limitations and need for further studies in the interpretation of both TCB and TSB levels. The nomogram supported by the AAP's 2004 policy was developed by Vinod Bhutani in 1999. The clinician utilizing the Bhutani nomogram should be aware of its limitations: (1) it was developed with a discrete population of newborns (2,840 newborns at an urban hospital in the USA, none with a positive DAT, and none requiring phototherapy before 60 h or NICU level care), (2) most of the newborns did not have a bilirubin obtained before 18 h or after 132 h. The latest 2004 policy statement of the AAP on hyperbilirubinemia for newborns ≥35 weeks, extrapolated from this nomogram to make suggestions on when to start phototherapy and when to consider an exchange transfusion. These are very helpful tools in making decisions, but each case needs to be evaluated individually. The use of electronic versions of these tools has been shown to

help in the management, including a free Web-based program (www.Bilitool.org).

Patients who do not clearly fall in the group requiring phototherapy or in the low-risk group need a repeat level to establish a trend or ensure that dangerous level is not reached. The timing of this repeat level is again dependent on the risk factors, including gestational age and feeding, social situations, the family's ability to assess and act upon the potential signs and symptoms of worsening hyperbilirubinemia, and the risk category of the initial level with most requiring repeated testing within 1–3 days. If multiple levels have been obtained, then the rate of rise can be used in addition to all of the other clinical indicators, keeping in mind the levels of some infants will not track as predicted.

The specific management of hyperbilirubinemia will be discussed in ❯ Chap. "Neonatal Hyperbilirubinemia".

Metabolic/newborn screening: The goal of newborn screening programs is to utilize reliable testing methods to detect disease prior to the onset of symptoms, when the early detection and treatment has proven to be effective in preventing the complications of the disease. Traditionally these screening programs began as the Guthrie blood spot for phenylketonuria (PKU) testing in newborns. Subsequently, other disorders were added, including congenital hypothyroidism, hemoglobinopathies (sickle cell), biotinidase deficiency, congenital adrenal hyperplasia (21 hydroxylase deficiency), maple syrup urine disease, and classic galactosemia. In May 2006, an expert panel of the American College of Medical Genetics (ACMG) published an executive summary of their process for developing their recommended core panel of 29 different disorders and 25 secondary targets for universal newborn screening. The main criteria used in their recommendations were divided into three main categories: (1) clinical characteristics including incidence, burden of disease, and presentation in the newborn, (2) analytic characteristics of the screening test, and (3) the diagnosis, treatment, and management of the disease including the availability of health professionals with experience with the disease. Their panel is summarized in ❯ *Table 11.5*. Since these 2006 recommendations, others have put forward the addition of severe combined immunodeficiency (SCID) to the universal newborn screening panel.

Maternal/Caretaker Aspects of Care

Much of what occurs after birth during the hospital stay is teaching or anticipatory guidance for the mother and family members who will be primary caregivers. The care and education is meant to optimize the health of the newborn and well-being of the expanding family during this time of transition. The following sections are key teaching points for the general care of newborns in the hospital stay and anticipatory guidance for the first few days at home. Teaching in the birth hospital stay occurs through many different methods, one of these is in modeling the care the staff/nurses provide to the newborn.

Skin to Skin/Rooming-In

One of the earliest and most important interventions in the first few hours of life is to provide skin-to-skin (STS) contact between mother and newborn. As the newborn is most alert for the first 2 h of life, STS can occur as quickly after birth (once stabilized if resuscitation is necessary) and for as long as possible. When initiated within ½ h of life and maintained for at least 1 h, STS has been demonstrated to improve the newborn's regulation of temperature and glucose, as well as neurobehavioral benefits (less crying, more flexed movements). The STS benefits for mothers include increased demonstration of affection, more parental confidence, less breast engorgement pain, and less anxiety. Breastfeeding dyads with STS achieve effective breastfeeding twice as fast as controls, increased rates of breastfeeding at time of discharge, and longer duration of breastfeeding. Additional benefits for the dyad were found in Russia with the implementation of the World Health Organization's (WHO) Ten Steps to Successful Breastfeeding. Here, they showed that the benefits went beyond breastfeeding and found a reduced rate of infant abandonment. Step 7 of Ten Steps is to practice "rooming-in," where mother and infant are allowed to remain together 24 h a day. Studies have demonstrated that rooming-in increases milk volumes by day 4 and in some studies increased breastfeeding duration by 4 months. This early contact is theorized to better introduce the dyad to each other's cues and encourage on-demand feeding.

Feeding

Mothers should be encouraged to feed their newborns on demand. Ideally, this would mean feeding with those first early cues of hunger which include rooting, sucking on hands or lips, starting to wake and stir, before the newborn escalates to crying. It is not always possible to do this, but feedings are more successful when the infant is in a calm

Table 11.5
ACMG newborn screening panel

	Core panel (29)	Secondary targets (25)
Organic acid metabolism	Isovaleric academia (IVA) Glutaric academia type 1 (GA 1) 3-Hydroxy-3-methyglutaric aciduria (HMG) Multiple carboxylase deficiency (MCD) Methylmalonic academia (MUT) 3-Methylcrotonyl-CoA carboxylase (3MCC) Methylmalonic academia (Cbl A,B) Propionic academia (PROP) Beta-Ketothiolase deficiency (BKT)	Methylmalonic academia (Cbl C,D) Malonic academia (MAL) Isobutyryl-CoA dehydrogenase (IBG) 2-Methyl-3-hydroxybutyric (2M3HBA) 2-Methylbutyryl-CoA (2MBG) 3-Methylglutaconic aciduria (3MGA)
Fatty acid metabolism	Medium-chain acyl-CoA (MCAD) Very long-chain acyl-CoA (VLCAD) Long-chain L3 hydroxyacyl- (LCHAD) Trifunctional protein deficiency (TFP) Carnitine uptake deficiency (CUD)	Short-chain acyl-CoA (SCAD) Glutaric academia type II (GA2) Medium/short-chain l-3hydroxyacyl-CoA (M/SCHAD) Medium-chain ketoacyl-CoA thiolase deficiency (MCKAT) Carnitine palmitoyltransferase II (CPTII) Carnitine/acylcarnitine translocase deficiency (CACT) Carnitine palmitoyltransferase I deficiency (liver) (CPT IA) Dienoyl-CoA reductase deficiency (DE RED)
Amino acid metabolism	Phenylketonuria (PKU) Maple syrup urine disease (MSUD) Homocystinuria (HCY) Citrullinemia (CIT) Argininosuccinic acidemia (ASA) Tyrosinemia type I (TYR I)	Benign hyperphenylalaninemia (H-PHE) Tyrosinemia type II (TYR II) Defects of biopterin cofactor biosynthesis (BIOPT-BS) Argininemia (ARG) Tyrosinemia type III (TYR III) Defects of biopterin cofactor regeneration (BIOPT-REG) Hypermethioninemia (MET) Citrullinemia type II (CIT II)
Hemoglobin-opathies	Sickle cell (Hb SS) Hemoglobin S Beta Thal (Hb S/Beta Th) Hemoglobin S/C (Hb S/C)	Variant including Hgb E (Var Hb)
Other	Congenital hypothyroidism (CH) Biotinidase (BIOT) Congenital adrenal hyperplasia (CAH) Galactosemia (GALT) Hearing screening (HEAR) Cystic fibrosis (CF)	Galactokinase deficiency (GALK) Galactose epimerase deficiency (GALE)

Source: Adapted from Watson (2006) and the ACMG

alert state. It is very common for newborns to sleep for long periods of time in the first day and can continue to do so for a few weeks. During this time, there may be times when the mother needs to wake the newborn to feed. A healthy satisfied newborn will wake easily (or with the gentle to direct encouragement such as undressing or a diaper change), and then they will feed actively, only to quickly fall back to sleep when the feeding is complete. In general, the goal for breastfeeding would be 8–12 feedings a day, which averages out to be a rough goal of every 2–3 h. For newborns taking formula, which is not as easily digested, the feedings might be spread out longer to every 3–4 h, but then the diaper changes might not be as pleasant. The newborn's stomach is smaller than their fist (which is an estimated volume of 5–7 mL), it expands to a little less than an ounce by day 3 and to 2–3 oz by 10 days of life. Ameda has a Belly Balls Lactation Education Tool, which visually demonstrates this for mothers (volumes correspond to

marble, ping-pong ball, and extra large chicken egg). Another helpful way to help parents gauge volumes (which is more applicable for bottle feeding) is to expect up to ½ oz per feeding on day 1, and then increase feeding volume by ½ oz each day until they reach 2–3 oz each feeding by day 3–4, which many continue for the first couple of weeks.

Elimination and Weight

The adequacy of feeding can be determined by the adequacy of elimination (specifically stooling) and with daily weights. The number of wet diapers (urination) does not correlate as well with hydration or the adequacy of elimination as newborns do not concentrate their urine well. Diapers can also be weighed to strictly quantify elimination; however, this is not necessary with the otherwise well newborn. A rough rule of thumb to help evaluate the adequacy of urination would be for one wet diaper each day for every day old (e.g., one on day 1, two on day 2, three on day 3, etc. until they get to seven to eight wet diapers by a week of age). Less than that would be suggestive of dehydration, which in the newborn is usually due to inadequate intake. Most full-term newborns will pass meconium in the first 24 h (late preterm by 36 h). Those who have not should have their feeding reviewed and have careful examination of their abdomen and anus. Findings consistent with obstruction such as abdominal distention or feeding intolerance should be urgently evaluated with the concurrent initiation of intravenous fluids while the newborn is being evaluated and remains NPO. Those without evidence of obstruction can be examined and gently stimulated with a small gloved digit (inserted no more than 2 cm). If there is still no passage of meconium, then the newborn should be evaluated with an AP abdominal radiograph to evaluate for the possibility of meconium plug, meconium ileus (associated with cystic fibrosis), Hirschsprung's disease, or other lower abdominal obstruction (imperforate anus).

Normal stooling pattern is at least one good size stool a day (size of a quarter), with stool transitioning from meconium by day of life 3–4. Ideally, the newborn who is breastfeeding well will have at least three, and up to eight to ten stools a day (the gastrocolic reflex can produce stool with every feeding). Breastfeeding newborns should have this frequent stooling, but may at about 1 month of age develop their own stooling pattern which can even be less than once a day. Until that time, breastfeeding newborns should be evaluated for dehydration in the presence of decreased stooling. Newborns will make funny faces while stooling (including bearing down and getting red), which is normal as long as the stools are soft and not hard little pellets. The breastfeeding newborn's stool will transition from meconium to yellow seedy. The formula feeding newborn's stool may transition from meconium earlier (perhaps day 1–3) but the resulting texture and color is not as predictable. Weighing newborns daily in the birth hospital setting is an additional tool to evaluate the adequacy of feedings. The average breastfeeding newborn will lose about 2–3% of their birth weight each day with an expected total average loss of 6–8%. Those who lose more than 3% in a day, or who are between 8% and 9% below birth weight should have their latch and feeding history reviewed. This is a good time to make any necessary interventions, including getting lactation services involved to help with the development of a feeding plan. This could also include more frequent weights to help assess whether the feeding plan/interventions are helping. Ten percent or more weight loss would currently be considered excessive weight loss in the USA, and one would want to make sure the mother is supplementing, ideally with expressed breastmilk (EBM), and depending on the clinical scenario, possibly formula if EBM is not available. Newborns with more than 10% weight loss should have their hydration status evaluated with a clinical exam. And those clearly above 10% weight loss and not improving (especially with other findings like those readmitted with hyperbilirubinemia) should have their electrolytes (especially sodium) evaluated for hypernatremic dehydration. Prior to discharge from the birth hospital, it would be best to prove that this plan can stabilize the weight loss, if not demonstrating minimal weight gain. These dyads will need careful follow-up to make sure the feeding and weight is improving. The late preterm infant (LPTI) is even more susceptible to these feeding challenges.

Umbilical Cord Care

Topical care of the umbilical cord has many cultural or traditional variations. Some of these may have some benefit (perhaps olive oil) and others (coal, spices, cow dung, ash, machine oil, turmeric, mustard oil, and dried banana) may be harmful. It is theorized that the earlier the cord stump separation the better to reduce the risk of introducing microorganisms as the necrotic tissue of the stump is an excellent medium for bacterial growth. In addition to best cord care practices in preventing omphalitis, it is important to provide Tetanus toxoid

immunization to pregnant women, clean birthing surfaces, clean cord tying and cutting devices, thermal regulation (with skin-to-skin contact and a hat), and employ hand washing during the delivery and newborn care. Hand washing by the birth assistant and before cord care has been shown to be the most effective in preventing omphalitis in developing countries. Many have suggested that in otherwise clean conditions with good hand washing, that serial inspections or "dry" cord care is viable option. Recent literature reviews have not found a difference between topical agents (triple dye, alcohol, chlorhexidine, etc.), and most have favored dry cord care in developed countries.

The WHO has developed and is now distributing clean delivery kits (CDKs). Their program also promotes keeping the cord clean and dry. However, the feasibility and effectiveness of using topical antimicrobials in developing countries with perhaps less clean conditions or where traditional cord care methods might be harmful is currently being investigated. There is preliminary evidence from the Projahnmo Study in Nepal that cord cleansing with 4.0% chlorhexidine in the first 24 h of life could reduce neonatal infection by 87% and mortality by 34%. More data are needed to promote this as a worldwide initiative, but the preliminary results are encouraging.

Safe Sleep Environment

Newborns can spend up to 20 h a day sleeping in the first few days of life and continue to need lots of sleep each day for the first few months. Therefore, sleep positioning and the sleep environment are very important to the newborn's health. Public health interventions with the "Back to sleep" program have demonstrated a dramatic decline in the rate of sudden infant death syndrome (SIDS) in the USA. However, the uptake of this message has been variable in different ethnic and cultural groups with a variety of barriers identified. Additionally, worldwide there are a variety of cultural practices related to newborn sleep environment. Many cultures practice bed sharing between the newborn and mother without evidence of effect on infant mortality or rates of SIDS. However, these may be confounded by the fact that these mothers may be breastfeeding more with its likely protective effects against SIDS. In the USA, there is strong epidemiologic evidence that bed sharing with adults raises the risk of SIDS. This is especially so when co-sleeping in waterbeds or soft surfaces like couches or chairs, as well as when the co-sleeping adult has ingested substances that alter alertness (like alcohol, as well as prescribed, over the counter or illicit drugs). Expansion of the safe sleep educational program includes parental education about the risks of co-sleeping, smoking cessation, and modeling of the safe sleep environment of the child. It has been demonstrated that when nursery staff practice placing newborns supine in a safe sleep environment, there is better adoption of these recommendations. The safe sleep environment for a newborn should be located as close to the mother as possible to promote breastfeeding while being separate from the adult bed. The safe sleep environment should be free of loose bedding, fabric near the head, stuffed animals or pillows, bumpers, and fluffy blankets or comforters.

Injury Prevention/Shaken Baby Syndrome Awareness

Shaken baby syndrome (SBS) is a devastating condition of brain injury due to violent shaking of a newborn or young child. Symptoms of SBS include apparent life-threatening events (ALTEs), retinal hemorrhage, subdural hemorrhage, permanent brain injury, and a mortality rate of close to 40%. Identified risk factors include male infant, firstborn, twin or other multiple, prematurity, low birth weight, difficult temperament/difficult to console, in utero exposure to substances causing withdrawal, drug or alcohol use, history of domestic violence, young unmarried mother with less than a high school education, and living with nonrelated adult. Some hospital-based programs are showing promising results with educational interventions that discuss the dangers of SBS, give information about child development, and provide suggestions toward nonviolent behavior management. These management plans need to help the parent or care provider recognize their own limitations, acknowledge their stress, and develop a plan in advance of when these situations arise.

Discharge and Post Hospital Follow-Up

The pediatric care provider should make sure that the mother and family have a good understanding of the care of their newborn. This would include discussion of both issues of safety and general care of their newborn. Ideally, this is done over more than one visit in the birth hospital, as research has demonstrated that postpartum mothers do not retain as much information as other patients. It is important to tailor these instructions to

match the infant's clinical scenario and to meet the parents' educational needs. At a minimum, the following safety issue should be covered in each discussion: how and when to contact the pediatric care provider after discharge, the signs and symptoms of jaundice, omphalitis, respiratory distress, sepsis, and how to take a temperature. Additional care topics that should also be reviewed include feeding, elimination, cord care, safe sleep positioning, and if applicable car seats and circumcision care. *Table 11.6* contains a sample list of topics discussed as discharge anticipatory guidance.

The AAP recommends that every newborn gets seen by a trained professional 2–3 days after discharge from the birth hospital to minimize the risk of excessive bilirubin levels and to encourage optimal breastfeeding. This can be done either by a physician or by a physician extender/nurse specialist experienced in newborn care. This and subsequent scheduled follow-up is likely more important in preventing hyperbilirubinemia and its consequences than many other interventions. This visit establishes the medical home as an outpatient and allows the physician to assess the newborn when it is at the most risk for hyperbilirubinemia. For those newborns with additional concerns such as risk factors for hyperbilirubinemia, difficulty breastfeeding, excessive weight loss, those discharged prior to 48 h of life, the LPTI, or with concerns about either the social situation or about maternal adjustment should be seen in 24–48 h after discharge. While there are many things to assess about the physical health of the newborn at this visit, it is also great time to reinforce the strengths of the dyad as the first few nights at home may leave parents with more questions than answers.

Table 11.6
Sample topics for discharge anticipatory guidance

Safety issues:
• How to call pediatrician and first appointment in 2–3 days (time/date)
• How to take rectal temperature, availability of thermometer, temperatures to notify PMD [if <97.5°F (36.4°C) or >100.4°F (38.0°C) rectally]
• How to evaluate for jaundice, to call PMD if approaches umbilicus or symptoms of hyperbilirubinemia develop
• Safe sleep environment
• Back to sleep, safe bedding, SIDS prevention
• Car seat (backward for at least the first 2 years and minimum 20 lbs, backseat in middle), where to get checked
• Smoke detectors (check each month)
• Temperature of hot water heater (<120°F)
• Injury prevention/SBS (shaken baby syndrome)
Care issues:
• Care for umbilicus, signs of infection, and when it should fall off
• Bathing
• Feeding: breast, bottle
• Urination and defecation (expected numbers and consistency)
• Dressing
• Sibling rivalry/adjustment
Parent concerns:
• As directed by discussion, give ample time and encourage the parents to ask questions

Management of Common Newborn Problems

There are many problems that occur in otherwise well newborns. A few that occur very commonly are discussed below.

Eye Discharge

Erythema, swelling, discharge, and conjunctival injection is consistent with conjunctivitis. In the newborn, this can be due to chemical conjunctivitis or infection. Factors to consider when evaluating neonatal conjunctivitis include organisms in the maternal birth canal, identification and treatment of maternal infections during pregnancy, adequacy of ocular prophylaxis, and potential trauma to the eye. Chemical conjunctivitis occurs soon after birth, lasts between 24 and 36 h, and is a reaction to the administration of ocular prophylaxis. There may be a linear erythema of the eyelids continuing onto the face or temples due to irritation of the surrounding skin. Incidence of chemical conjunctivitis is slightly higher with silver nitrate than erythromycin ointments. The presence of purulent discharge suggests an infectious etiology with Chlamydia trachomatis, the most common cause, followed by Neisseria gonorrhoeae, and then other bacterial and viral causes. Distinguishing between chlamydial and neisserial causes can usually be made based on timing and clinical appearance. Gonococcal conjunctivitis occurs earlier usually beginning within 24–48 h of life and is marked by profuse purulent discharge and eyelid edema. Chlamydial conjunctivitis appears later, most between 5 and 7 days (but can present up to 21 days)

with discharge that is initially watery progressing to mucopurulent. Although chlamydial conjunctivitis may be self-limited, it is important to test for nasopharyngeal colonization as treatment is necessary to prevent the development of pneumonitis. Diagnosis of bacterial conjunctivitis should include bacterial cultures and direct immunofluorescent antibody testing versus chlamydia. Treatment of chlamydial conjunctivitis requires oral antibiotics. Use of oral erythromycin has been associated with infantile hypertrophic pyloric stenosis but is still recommended by the AAP for treatment of chlamydial conjunctivitis after appropriate risk counseling with the parents. Treatment of gonococcal conjunctivitis requires systemic antibiotics, and with full evaluation for systemic disease in an intensive care unit. Additionally treatment of disseminated gonococcal disease requires treatment for 7 days and one should consider Cefotaxime instead of Ceftriaxone in newborns with significant hyperbilirubinemia (*Fig. 11.11*).

Viruses specifically herpes simplex virus (most commonly Type 2 but also Type 1) can cause neonatal conjunctivitis with serous to serosanguineous discharge. These may or may not appear with characteristic vesicles surrounding the eye. Prompt evaluation for CNS and disseminated HSV disease is prerequisite for determining length of treatment. Lastly commonly occurring clear watery to slightly yellowish discharge or tearing without conjunctival injection is consistent with dacryostenosis or lacrimal duct stenosis. Treatment includes warm compress or massage from outer to inner canthal folds to "milk the duct." Occasionally, these can become secondarily infected and would need topical antibiotics. A summary of the presentation and treatment of the major causes of neonatal conjunctivitis appears in *Table 11.7*.

Jitteriness

The newborn that is jittery or has an exaggerated Moro reflex should be evaluated for hypoglycemia or, less commonly, electrolyte abnormalities. With normal serum levels, the examiner should obtain a detailed obstetrical history to include risk factors for infection and potential exposures to medications (including SSRI's, opiates, etc.), illicit drugs, tobacco, and caffeine. The newborn should have a careful exam for signs and symptoms of infection and a complete neurological exam. Newborns with specific risk factors for infection (i.e., GBS positive mother, history of HSV or concurrent infection, maternal fever, prolonged rupture of membranes, chorioamnionitis, etc.) should be evaluated for infection and those with clinical manifestations of infection should be started on systemic antibiotic therapy. In the absence of risk factors or clinical manifestations, serial examinations should occur. Those with increasing jitteriness, additional neurological findings, or change in mental status including poor feeding should be evaluated for both CNS infection as well as neuroimaging to evaluate for a potential bleed or lesion. Once the other more worrisome etiologies have been eliminated as causes, and based on exposure history, one can start to think of neonatal withdrawal as the possible cause. In the case of opiates, this is described as neonatal abstinence syndrome (NAS) but has also been associated with other more commonly occurring substances such as SSRI, tobacco, and caffeine (see Chap. 34, "Miscellaneous Disorders" for a more detailed description). Lastly, there is a small subset of newborns who are neurobehaviorally more immature, but otherwise normal. These newborns and their families benefit from a complete evaluation with an occupational therapist performing a Neonatal Network Neurobehavioral Score (NNNS), with

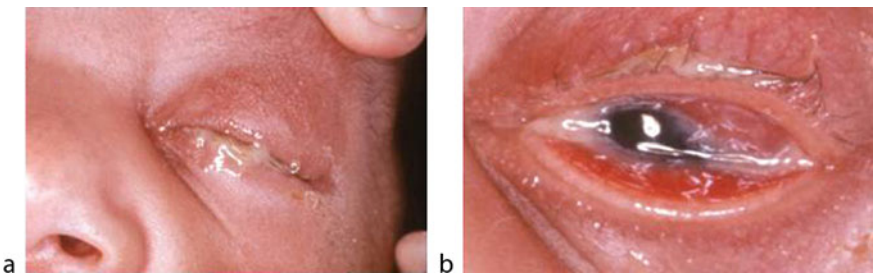

Figure 11.11
Newborn with conjunctivitis cause by Neisseria *gonorrhoeae*. (b) is a close up of the same patient in (a). In (b), note the collection of purulent eye discharge in the inner canthal region right after wiping the eye (Photograph from the patient files of James F. Padbury, MD)

Table 11.7
Summary of characteristics of common causes of neonatal conjunctivitis

Type of conjunctivitis	Agent/organism	Typical onset of symptoms	Description of discharge	Treatment
Chemical	Silver nitrate, or erythromycin prophylaxis	Birth to 1 day	Watery	Self-limited, warm compress
Bacterial	Chlamydia trachomatis	4–10 days (up to 21 days)	Watery then mucopurulent	Erythromycin PO (50 mg/kg/day in four divided doses per day for 14 days)
	Neisseria gonorrhoeae	1–4 days (up to 21 days)	Purulent and profuse, "hyper purulent"	Ceftriaxone IV or IM (25–50 mg/kg not to exceed 125 mg, once) and saline eye irrigation until resolution of discharge
	Gram positive including S. aureus, Streptococcal species, etc.	4–7 days (may be 2–21 days)	Mucopurulent (moderate)	Erythromycin 0.5% ointment topically to eyes four times a day for 3–7 days
	Gram negative including Haemophilus species, E. *coli*, etc.	5–10 days (may be 2–21 days)	Mucopurulent	Trimethoprim-polymyxin B or Gentamicin eye drops
Viral	Herpes Simplex Virus (Type 2 more common then Type 1)	6–14 days (may be up to 6 weeks of age)	Serous to serosanguineous	Acyclovir IV, (60 mg/kg in 3 divided doses per day for 14 days) and 1% trifluridine or 3% vidarabine topically to eyes

demonstration of modifications to care that would benefit their newborn. These newborn warrant close follow-up and prompt referral to early intervention services with any ongoing concerns.

Heart Murmur

Murmurs are very common in newborns, and most will resolve spontaneously. Roughly 80% of infants will have a transient murmur related to closing PDA in the first 24 h of age. The risk for pathologic murmurs/congenital heart disease (CHD) is higher in newborns with other anomalies, newborns with first-degree relatives with CHD, certain in utero exposures, and in infants of diabetic mothers (IDMs). Up to 30% of IDM newborns will have some form of CHD. Once a murmur is detected, subsequent action depends on its nature and a determination of whether it is a cause for concern. "Transitional murmurs" are common, have no clear structural basis and resolve spontaneously. Grade I–II, ejection (crescendo–decrescendo) murmurs, musical or vibratory in quality that are best heard on the left sternal border in an otherwise well newborn with normal femoral pulses, color, and capillary refill (<3 s) are usually benign. More worrisome murmurs are those associated with clinical signs or other anomalies, are harsh or blowing, holosystolic, obscure S1 or are diastolic, and grade III or higher. Transitional murmurs may start off being loud at a Grade III but then will generally decrease in intensity, sometimes even disappearing over the first 24 h. In contrast, pathological murmurs remain loud, intensify, or may develop later. In the first few days of life, murmurs may be very dynamic, due to changes in pulmonary vascular resistance.

For any worrisome murmur, or one that persists beyond 24–48 h, additional information should be obtained. The first step (when available) is to obtain a pre- and postductal pulse oximetry. The postductal SPO_2 in a full-term newborn after 4–6 h of age should be >95% on room air. Some authorities are proposing that a postductal saturation should become the fifth vital sign, or part of universal newborn screening. In general, the pulse oximetry has a good positive predictive value, and will detect about 98% of major congenital heart defects in the newborn period. However, the negative predictive value is not as good, because not all significant heart defects present with right to left shunting. The second step in evaluating the newborn's heart murmur is to obtain upper and lower extremity blood pressures. Presence of good femoral pulses does not rule out coarctation or interrupted arch, because flow across an open PDA may provide adequate systemic blood flow initially. The systolic pressures of the lower extremity should be higher than in the upper extremities (think higher pressure

downstream unless there is a dam blocking flow). Systolic pressure in the upper extremity that are ≥9–12 mmHg higher than the lower is worrisome. Blood pressure is highly state-related in the newborn, so abnormal blood pressures should generally be repeated and proper cuff sizes confirmed. If the screening SPO_2 and blood pressures are not reassuring, the newborn should be referred for cardiology evaluation and an echocardiogram. If the screening SPO_2 and blood pressures are reassuring, the newborn with a non-worrisome murmur and an otherwise normal exam can be followed with serial exams. In areas without access to cardiology or echocardiograms, additional information can be obtained from an EKG, looking primarily for right-axis deviation greater than expected for age (in the LUQ), as well as a PA and lateral chest radiograph to evaluate the cardiac silhouette for size (watch the thymus shadow which is best distinguished on the lateral), location (dextrocardia), shape (i.e., that classic "egg on a string" from transposition of the great arteries (TGA) and "boot shape" of tetralogy of Fallot (TOF)). The lung fields are assessed for pulmonary vascular markings (decreased in right-sided obstructive lesions or increased in mixing lesions with increased pulmonary blood flow). (For additional information on pediatric cardiology refer to ❯ Chap. "Pediatric Cardiology").

Omphalitis

Omphalitis or infection of the newborn's umbilical cord presents as discharge or oozing (4%), spreading erythema (6%), swelling, warmth, and tenderness (7%) of the cord stump. Redness extending more than 2 cm from the cord is generally consistent with infection. Mean time to presentation is about 2.5 days with a range from 1 to greater than 8 days. Estimates of omphalitis range from 1% to 16% of newborns depending on the criteria used in defining the diagnosis. The etiology of omphalitis traditionally includes *Staphylococcus (*both *aureus* and *epidermidis*), *Streptococcal* (group A), *Klebsiella pneumoniae*, *Escherichia coli*, *Proteus mirabilis*, and anaerobic *Bacteroides and Prevotella organisms*. With the implementation of antistaphylococcal cord care techniques such as triple dye, hexachlorophene, and alcohol, the incidence of gram-negative organisms have been increasing, although this may not be the case in developing countries. In most cases, omphalitis remains a localized infection, but complications can include neonatal sepsis and meningitis. Additionally, there can be rapid progression of the infection to the abdominal wall causing cellulitis and necrotizing fasciitis, which have a high risk of mortality. Treatment of omphalitis includes prolonged parenteral antibiotics.

Conclusion

Care of the newborn demands an attention to details, both in obtaining the maternal history and in completing the early exams as many subtle differences would be indications for adjustments in care to promote the well-being of the family and the newborn's development over time. This includes screening both in the primary or universal sense of all newborns (such as hearing and NBS programs) but also secondary screening for specific diseases (such as infection, for hypoglycemia in the IDM, and cardiac workup or screening with a murmur). Public health both nationally and internationally has its roots in maternal child care, and as such has had great impact in reducing infant mortality. Much of the care currently provided in nurseries is evidenced based only in that it has stood the test of time, and little of what is done has ever been scientifically evaluated. At present, newborn care is far from proven best practices. But we are moving toward that direction as exemplified by the work to determine the best systematic methods for screening for hyperbilirubinemia to prevent chronic bilirubin encephalopathy (kernicterus), and in evaluation of cord care techniques in real practice and developing countries. Until these and many other answers are obtained, one should continue to work toward providing the best of what is known so far, and in encouraging families to embrace the care of their newborns.

Resources

New Ballard Score: http://www.ballardscore.com/

World Health Organization:

(a) Evidence for the ten steps to successful breastfeeding: http://whqlibdoc.who.int/publications/2004/9241591544_eng.pdf

(b) Growth Curves: http://www.who.int/childgrowth/standards/en/

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