Tips for Medical Students and Non-Neonatologists on Physical Examination of the Newborn and Important Aspects of Early Newborn Care – An Irish Perspective

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Abstract:

Appropriate physical examination technique of the newborn infant is vital to ensure the detection of pathology and the timely instigation of required management. No infant should be viewed as 'routine,' and all babies must have a comprehensive physical examination completed prior to discharge home. This paper will outline an Irish approach to good physical examination technique of the newborn for a number of the more challenging and error-prone aspects of the physical exam, which non-neonatal specialists and medical students may find helpful.

Introduction

Appropriate physical examination technique of the newborn infant is vital to ensure the detection of pathology and the timely instigation of required management or onward referral. Medical students are typically instructed on neonatal physical examination during their paediatric clerkships and may not receive any additional neonatal training prior to graduation. The duration of paediatric and neonatal medical student clerkships varies between Irish universities. Many medical specialties interact with neonatal patients besides neonatal or paediatric departments including ophthalmology, orthopaedics, general surgery, dermatology, and general practice. In particular, approximately 2,950 family doctors (general practitioners, GPs) in Ireland provide essential services for newborn care including 2 and 6 weeks checks, monitoring feeding, weight gain, head growth, and development. (1) Such visits provide a key window of opportunity for the early detection of pathology.

The curriculum of the School of Medicine at the Royal College of Surgeons in Ireland (RCSI) is designed to give medical students a sound knowledge of the science and art of medicine. RCSI medical students receive 7 weeks of training in paediatrics during their 4th of 5 years of medical school, of which one week is dedicated specifically to neonatal training in a tertiary maternity hospital. During their week of neonatal clerkship, correct physical examination technique of the newborn is emphasised. Students attend several tutorials detailing neonatal physical examination, have the opportunity to perform neonatal physical examination safely on well infants on the postnatal wards and also have access to online videos teaching comprehensive assessment of the neonatal cardiovascular system, head, face and neck, gastrointestinal system, neurological system, and hip examination. At the end of their paediatric rotations, the students' neonatal physical examination skills are thoroughly tested via a clinical examination of a well newborn, to ensure high standards of clinical practice and safety after graduation. One of the authors (TC), a professor of neonatology, has noted an improvement in the clinical examination skills of RCSI medical students at the end of their rotation assessments in recent years. The majority of neonatal medical student education is now provided by postgraduate paediatric and neonatal trainees who have taken time out of their specialist training schemes to pursue full-time research for higher degrees. It is probable that education delivered by those pursuing neonatology as a career improves the knowledge base of students regarding the newborn physical examination.

It is critically important that all professionals involved in newborn care, including junior doctors, surgeons, midwives, and advanced nurse practitioners are fully versed in the appropriate physical examination technique of the newborn. No infant should be viewed as 'routine,' and all babies must have a comprehensive physical examination completed prior to discharge home. This paper will outline the Irish approach to good physical examination technique of the newborn for a number of the more challenging and error-prone aspects of the physical exam, which non-neonatal specialists and medical students may find helpful.

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General Inspection of the Newborn

Doctors performing newborn examinations should position themselves so that they easily look at both the parents and baby and smile reassuringly, to all, as needed. Well trained doctors will quickly observe the colour, respiratory status, level of alertness, posture, movement, and nutrition status of the infant.

The normal baby is typically a pale pink colour. Skin colour should be observed for cyanosis, pallor, jaundice, and plethoric appearance. Central cyanosis should be assessed under the infant's tongue, is always an abnormal finding and may indicate a congenital heart lesion or lung pathology. Acrocyanosis, cyanosis of the extremities, particularly of the soles of the feet and palms of the hands, is a normal finding and typically caused by the infant being cold. Neonatal pallor warrants a prompt assessment for potential sepsis or anaemia. Neonatal jaundice is a common finding, particularly in breastfed infants. Jaundice which appears before 24 hours of age is pathological until proven otherwise, and appropriate investigations for immune-related haemolysis (Rhesus or ABO incompatibility), congenital infection, sepsis, and biliary obstruction should follow. A plethoric, or 'ruddy,' appearance to the baby is usually related to polycythaemia. Polycythaemia is defined as a central haematocrit > 65% and is commonly associated with maternal gestational diabetes mellitus, trisomy 21 and recipients of twin-to-twin transfusion.

General inspection of the baby's respiratory system includes observation for signs of respiratory distress, including tachypnoea (respiratory rate over 60 breaths per minute), nasal flaring, intercostal, and subcostal recession. Grunting, defined as forced expiration against a partially closed glottis, is a significant sign of respiratory distress as the baby is attempting to generate their own positive airway pressure.

The level of consciousness of the baby should be automatically assessed during the general inspection. There are 5 levels of

consciousness (LOC) that a newborn may assume; alert, hyperalert, lethargic, stuporous, and comatose. An 'alert' baby is a normal baby; the baby will assume a semi-flexed posture, move their limbs symmetrically and spontaneously, have spontaneous eye-opening, interact with their environment, and be consolable. A 'hyperalert' baby is baby hyperalert to environmental stimuli, often inconsolable, requires frequent soothing, has exaggerated primitive reflexes and feeding difficulties. A baby exhibiting signs of hyperalertness may potentially be withdrawing from maternal medication, prescribed or illicit, or developing central nervous system pathology such as meningitis or encephalitis. The decreased LOC states include lethargy, stuporous and comatose and always require immediate attention. A lethargic baby will be active on handling but will be quiet and non-responsive when not stimulated. A stuporous baby will only respond to noxious stimuli, such as firm sternal rub, while a comatose baby will not respond to noxious stimuli at all. The differential diagnosis for decreased LOC of the newborn is large and includes sepsis, hypoxic ischaemic encephalopathy, meningitis, encephalitis, hypoglycaemia, and inborn errors of metabolism.

Head Circumference (HC)

Figure 1: Measuring the Head Circumference

The head circumference should be measured at its maximum by positioning the measuring tape around the most prominent part of the forehead and the most prominent part of the occiput. The measuring tape should be tight, so as not to over-estimate the HC, with the numbers facing out. The HC should be taken at the intersection of the blue lines on the measuring tape, in this case, 36.8cm (Figure 1). The normal range of HC in a term infant is 32cm to 37 cm. The HC should be plotted on an appropriate centile chart and considered in tandem with the weight and length of the baby as well as its growth trajectory. The most common cause of macrocephaly is familial macrocephaly. However, rarer causes include hydrocephalus, Fragile X, and Sotos syndromes, mucopolysaccharidoses, and neurofibromatosis. Microcephaly is typically a more sinister entity, the differential diagnosis of which includes intrauterine growth restriction, congenital infection (TORCH infection, Zika virus), genetic abnormalities, metabolic disease, periventricular leukomalacia, neuronal migration disorders, and craniosynostosis. (2,3)

Eye Examination

Figure 2: Examination of the eye for the red reflex

The newborn eyes should be structurally assessed for the presence of hypertelorism, hypotelorism, epicanthic folds, and coloboma, all of which may form part of a dysmorphic phenotype. Of great importance for each newborn is examination with an ophthalmoscope to confirm the presence of bilateral red reflexes. The ophthalmoscope is held in the examiner's hand, and the baby's eye is gently opened with the other hand, as shown in Figure 2, to inspect for the red reflex. An absent red reflex indicates congenital cataract secondary to a congenital infection, genetic disorders including trisomy 21 or metabolic disease such as galactosemia.

(4) On very rare occasions, intraocular tumours may cause an absent red reflex.

Examination of the Cardiovascular System & Palpation of the Femoral Pulses

Figure 3: Palpation of the femoral pulses

> ***" Absent or weak femoral pulses are a concerning clinical sign and may indicate a left-sided obstructive heart lesion including a left hypoplastic heart, aortic coarctation, aortic stenosis or interrupted aortic arch. (5)"***

On examination of the cardiovascular system, the infants colour, respiratory status, capillary refill time, and precordial activity should be assessed. An active precordium may indicate the presence of left-to-right shunting. A thrill is a palpable murmur while palpation of a heave indicates right ventricular hypertrophy. Innocent, transient heart murmurs are often detected in the first days following delivery and are commonly related to the closure of the patent ductus arteriosus. On auscultation of a heart murmur, the murmur should be classified according to its grade, location, relation to systole, radiation, and whether the infant is symptomatic or asymptomatic. Clinical symptoms and signs associated with congenital heart disease include cyanosis, lethargy, tachypnoea, poor feeding, slow weight gain, hepatomegaly, and low oxygen saturations. Bilateral palpation of the femoral pulses forms an integral part of the neonatal cardiovascular examination. The femoral pulses are located halfway between the anterior iliac spine and the pubic symphysis. Palpation of the femoral pulses may be difficult when the baby is crying, tachypnoeic, or tensing their abdominal wall musculature. Placing the infant into a 'diamond' position, with both legs abducted and the soles of their feet opposed, as per Figure 3, can alleviate these issues and allow easier palpation of the femoral pulses. Absent or weak femoral pulses are a concerning clinical sign and may indicate a left-sided obstructive heart lesion including a left hypoplastic heart, aortic coarctation, aortic stenosis or interrupted aortic arch. (5)

Palpation of the liver

Figure 4: Palpation of the liver

Palpation of the neonatal liver should begin in the right iliac fossa and progress to the right costal margin. Steady pressure should be applied to the abdomen, and it is normal for up to 1cm of the liver edge to be palpable below the right costal margin. With the hand that is not being used for abdominal palpation, the abdomen can be relaxed by grasping the ankles and holding the legs at right angles to the abdomen. The abdomen should relax if you wait patiently in this position. Differential diagnosis of neonatal hepatomegaly includes congestive heart failure, congenital infection, haemolytic disease of the newborn, and metabolic disease. (6)

Palpation of the Testes

The testes are present in the scrotum in 98% of full-term male infants. The inguinal canal should be obliterated by placing the index finger over it during palpation of the testicle in the scrotum. This is to ensure that retractile testicles cannot ascend the inguinal canal during the examination. Failure of the testes to descend by 6 weeks of age is abnormal. (7) As per Haid et al., persistent undescended testes at 6 months of age in a term boy should be actively treated with orchidopexy performed to ensure the testes are in a scrotal position by 12 months of age. (8) Delayed management of undescended testes may promote future infertility with lower sperm concentrations inversely associated with the age of correction. (9)

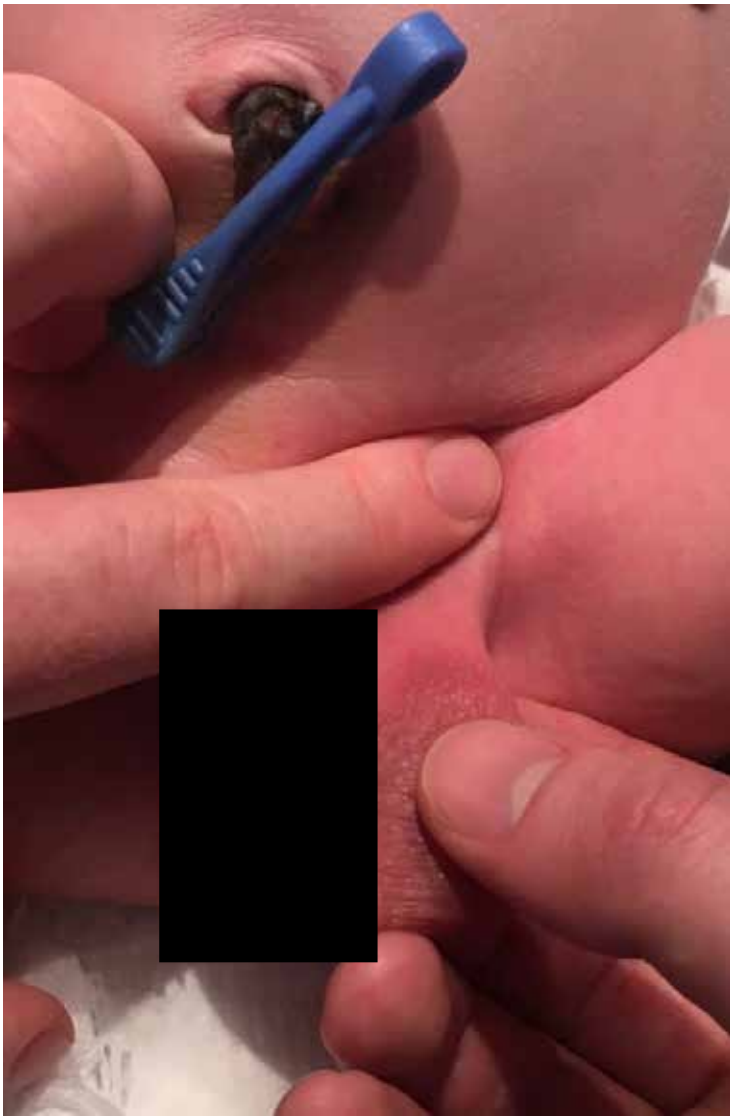

Figure 5: Palpation of the left testicle with obliteration of the left inguinal canal

Examination of the Hips

"If a baby is found to have a positive Barlow or Ortolani test, a hip ultrasound should be performed prior to discharge home to assess for dislocation. If risk factors for Developmental Dysplasia of the Hips (DDH) exist or a hip click is found on hip examination, a hip ultrasound should be arranged for the infant at 6 weeks corrected gestational age to determine hip subluxation vs. hip dysplasia."

Figure 6: Barlow Test (1): One hip is tested at a time (the left hip in this case). The pelvis is stabilised, and the knees and hips are flexed to 90 degrees

Figure 7: Barlow Test (2): The examiners fingers are placed over the femoral head and the hip is gently adducted downward to assess for hip dislocation

Figure 8: Ortolani Test: With their fingers still placed over the femoral head of the hip being assessed, the examiner gently abducts the thigh

The hips are examined for evidence of developmental dysplasia of the hip (DDH) with the Barlow and Ortolani manoeuvres. The Barlow test assesses whether the hip is dislocatable. To perform the Barlow manoeuvre the baby's knees and hips are flexed at 90 degrees, the pelvis is stabilised, and one hip is tested at a time (Figure 6). The examiner places their fingers over the femoral head of the hip to be tested and gently adducts it downward (Figure 7). Dislocation is palpable as the femoral head slips over the posterior lip of the acetabulum. (7) The Ortolani test examines if a dislocated femoral head, either congenitally dislocated or dislocated secondary to the Barlow test, may be reduced into the acetabulum. With their fingers still placed over the femoral head of the hip being assessed, the examiner gently abducts the thigh (Figure 8). The test is positive if the examiner senses reduction of the femoral head into the acetabulum by palpating a 'clunk' and movement forward of the femoral head. Risk factors for DDH include breech presentation, a positive family history in a first-degree relative, and fixed talipes. If a baby is found to have a positive Barlow or Ortolani test, a hip ultrasound should be performed prior to discharge home to assess for dislocation. If risk factors for DDH exist or a hip click is found on hip examination, a hip ultrasound should be arranged for the infant at 6 weeks corrected gestational age to determine hip subluxation vs. hip dysplasia.

Newborn Screening Assessments

All physicians involved in neonatal care should be fully versed on the newborn screening assessments in place for infants born in their jurisdiction, their utility, limitations, and appropriate management of babies with positive screens. Every baby in Ireland undergoes several newborn screening assessments prior to discharge home. The universal heel prick test screens for cystic fibrosis, congenital hypothyroidism, phenylketonuria, classical galactosaemia, glutaric aciduria type 1, medium-chain acyl-CoA dehydrogenase deficiency, homocystinuria, and maple syrup urine disease. (10) Early detection of these rare disorders is essential to instigate appropriate management and minimise associated morbidity. A newborn hearing screening programme (NHSP) was implemented in Ireland in April 2011 to detect permanent childhood hearing impairments and facilitate enrolment in early intervention programmes by 6 months of age. (11) Pulse oximetry to evaluate for the presence of congenital heart disease is performed on all Irish infants prior to discharge home, ideally after the first 24 hours of age. Although newborn pulse oximetry screening has a specificity of 99.9%, it is important to note that certain cardiac defects including coarctation of the aorta, interrupted aortic arch and some forms of total anomalous pulmonary venous return may not be detected by this screening tool. (12) Many Irish maternity hospitals also perform a transcutaneous bilirubin check prior to discharge home; this is especially relevant for those babies of African or Asian ethnicity where jaundice may be more challenging to assess visually.

Useful Advice for New Parents

The newborn physical examination is an excellent opportunity to form a good rapport with parents, provide advice for newborn care, answer questions, and provide reassurance. Breastfeeding should be encouraged, and the benefits of breastmilk promoted to parents; breastfeeding encourages maternal bonding with baby, provides natural and complete nutrition, prevents infection via maternal immunoglobulin and protects against future obesity. (13) The importance of appropriate sleeping practices should be emphasised. The 'Back to Sleep' campaign was launched in 1994, and since then, a reduction in over 50% of sudden infant death syndrome (SIDS) cases in the United States has been achieved. (14) As such, all infants should be placed on their backs when going to sleep, with their feet at the bottom of the cot, one breathable blanket to cover them and no pillows or toys in the cot around the baby. Smoking in the household should be discussed as a significant risk factor for SIDS and parents directed to appropriate supports for smoking cessation. Many neonatal units and maternity hospitals implement an infant 'car seat challenge' prior to discharge home to assess safe positioning of the infant in the car seat. This is especially relevant for infants born prematurely, who may experience apnoea, bradycardia, and oxygen desaturations if malpositioned in a car seat. (15) The newborn examination may also provide time to mention the value of immunizations, inform parents of the immunization schedule, and correct misconceptions they may have regarding vaccination.

In conclusion, a comprehensive physical examination of the newborn is essential. Appropriate training in neonatal physical examination technique for medical students and physicians working outside of neonatology is vital to ensure that newborns interacting with such services are examined thoroughly, and any pathology present promptly identified. We have outlined some of the more challenging aspects of the newborn physical exam, which are often performed incorrectly. We hope these tips may ameliorate such difficulties or errors in technique and be helpful for the non-neonatologist reviewing a newborn infant.

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