Assessment of the Neonate

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This Presentation is Approved for
1 CRCE Credit Hour

Learning Objectives

- Interpret findings pertaining to the physical assessment of the newborn
- Interpret findings pertaining to the physiological assessment of the newborn

Neonatal Scoring Systems

Apgar Score

- Rated at 1 and 5 minutes
- Intended only to assess general condition
- Does not
  - Define asphyxia
  - Predict future development
  - Influence Ivy League admission
- Healthy premature infants will likely have low Apgar scores

FYI see link below on use and abuse of Apgar score

Apgar Scoring System

- Observations
  - Color - skin colorimetry reflects illness severity
  - Heart rate
  - Reflex activity
  - Activity
  - Respirations

Apgar Scoring System

	0	1	2
Color	Central Cyanosis	Peripheral Cyanosis	Pink

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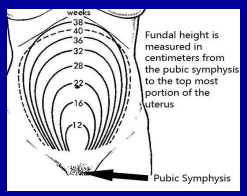
Reflex	None	Grimace (withdraw)	Crying
Muscle Tone (Activity)	Flaccid	Some flexion	Well-flexed

Gestational Age Estimation

- Prenatal
  - Menstrual cycle - 1st day of last menstrual cycle + 280 days
  - Fundal height measurement – mom's abdomen
  - Ultrasound



Gestational Age Estimation

- Postnatal
  - Ultrasound measurement - femur length
  - Ballard Score - aka Ballard-Dubowitz Score

Ballard Score

- Estimation of Gestational Age
- Physical Signs
  - Skin
  - Breasts
  - Lanugo
  - Eye/Ear
  - Plantar surface
  - Genitalia

FYI see link below to view Ballard Score Video

Ballard Score - Physical Signs

Gestational Age Score	24-26 weeks Score = 0	35-40 weeks Score = 4
Skin	Gelatinous, red, translucent	Parchment, deep cracks, no visible vessels

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Plantar Surface	No crease	Creases over entire sole

FYI see links below to view skin coloring, lanugo scoring, & plantar surface scoring

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Breasts	Barely perceptible	Full areolae 5-10 mm bud

See link below to view breast scoring

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Eyes and ears	Lids open, pinna flat & stays folded	Eyes open, ear thick cartilage, stiff

See link below to view eye & ear scoring

Ballard Score - Physical Signs

Gestational Age Score	24-26 weeks Score = 0	35-40 weeks Score = 4
Genitalia – male	Scrotum empty Faint rugae	Testes pendulous Deep rugae
Genitalia – female	Prominent clitoris Small labia minora	Majora cover clitoris and minora

See links below to view male & female genitalia scoring
FYI see link below for pictures of ambiguous genitalia

Ballard Score Neuromuscular Signs

- Posture
  - Degree of extremity flexion
  - Greater flexion → maturity
- Square window
  - Flexion of hand to forearm
  - Greater flexion → maturity

See links below to view posture & square window scoring

Ballard Score Neuromuscular Signs

- Arm recoil
  - Recoil of arm after full extension
  - Full recoil → maturity
- Popliteal angle
  - Angle of knee, with thigh on chest
  - Lesser angle → maturity

See links below to view arm recoil & popliteal angle scoring

Ballard Score Neuromuscular Signs

- Scarf sign
  - Put hand on opposite shoulder
  - Lesser travel of elbow across midline → maturity
- Heel-to-ear
  - Non-forceful movement of heel to ear
  - Greater distance heel-to-ear → maturity

See links below to view scarf sign & heel-to-ear scoring

Ballard Scoring

- Maturity ratings
  - 0 24 weeks
  - 10 28 weeks
  - 20 32 weeks
  - 30 36 weeks
  - 40 40 weeks
  - 50 44 weeks

See link below to view Ballard Score calculator

Acute Illness Scoring

- Purposes
  - To predict mortality
  - Guide patient management
  - Set standards for research, benchmarking across institutions

Acute Illness Scoring

- Score systems
  - Score for neonatal acute physiology (SNAP II)
  - Clinical risk index for babies (CRIB II)
  - Oxygenation index (later section)
- Validity – CRIB II may be more discriminatory
- Scoring systems are not very good at predicting mortality

Acute Illness Scoring

- Parameters SNAP II
  - Mean blood pressure
  - Lowest temperature
  - PO_2/F_iO_2%
  - Lowest pH
  - Multiple seizures
  - Urine output
  - Apgar score
  - Birth weight
  - Small for gestational age

Acute Illness Scoring

- Parameters CRIB II
  - Gender
  - Gestation weeks
  - Birth weight
  - Admission temperature
  - Base excess

FYI see links below to view
SNAP II & CRIB II score calculators

Normal Physical Features

- Lanugo – fine hair
- Peripheral cyanosis – due to reduced peripheral perfusion
- Vernix caseosa – white coating
- Fontanelles – anterior, posterior

Normal Physical Features

- Lanugo – fine hair
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- Fontanelles – anterior, posterior
- Physiologic jaundice ≥ 24 hours postpartum
- Telangiectatic nevi – "stork bites"
- Minimal ecchymoses & petechiae

See link below to view stork bite

Normal Physical Features

- Respirations
  - Normal RR = 30-60/min
  - Auscultation → sounds transmitted easily across small chest
  - Periodic breathing – apnea < 10 sec
    - Normal in preterm newborns
    - Non-pathologic
  - Apnea of prematurity – apnea > 10 sec

Silverman Respiratory Status Index

- Purpose: objectively score physical evidence of increased work of breathing (WOB)
- Five observations, scored 0-2
- Higher score → greater WOB (maximum score = 10)

Silverman Respiratory Status Index

- Parameters
  - Synchrony of upper and lower chest: seesawing = 2
  - Nasal flaring: marked = 2
  - Lower chest retractions: marked intercostal retractions = 2
  - Xiphoid retractions: marked retractions of skin over xiphoid = 2
  - Expiratory grunt: audible to ear = 2

See link below to view Silverman scoring system

Cardiovascular Assessment

- HR = 120-160/min
- BP (term infant) = 50-70/25-50
- Umbilical stump – 2 arteries, 1 vein

See link below for more information on neonatal blood pressure

Cardiovascular Assessment

- Auscultation for murmurs – turbulent blood flow across valves
  - Abnormal valves
  - Abnormal vessels
  - Septal defects
- Brachial pulses compared to femoral for equal intensity – unequal → aortic coarctation

FYI see link below for website with heart murmurs
See link below for more information & pictures of coarctation

Neurologic Responses (Reflexes)

- Grasp: grasps with hand
- Suck: starts early, in utero
- Rooting: turns head to suck
- Moro: startle reflex
- Babinski: normal newborns toes curl upward

See link below for video of neonatal reflex evaluation (2.5 min)

Abnormal Features

- Meconium stains: aspiration
- Flaring, grunting, retractions
- Central cyanosis: hypoxemia
- Jaundice < 24 H postpartum
  - Color due to bilirubin
  - Causes: hemolysis, liver failure

Abnormal Features

- Fontanelles – anterior and posterior
  - Bulging → increased ICP
  - Sunken → dehydration
- Upper extremity immobility
  - Broken clavicles
  - Brachial plexus injury

See links below to view radiograph of birth trauma & a picture of birth trauma (forceps marks)

Abnormal Features

- Facies
  - Micrognathia (small mandible)
  - Pierre-Robin syndrome
  - Treacher Collins syndrome
  - Microstomia (small mouth) – trisomy 18
  - Cleft lip, palate

See links below to view images of micrognathia & trisomy 18

Abnormal Features

- Cri-du-Chat (cat's cry) – deletion of partial chromosome (normal in feline newborns)
- Simian crease – single palmar crease
  - Present in some normal infants
  - Common in Trisomy 21 (Down syndrome)
  - Common in Cri-du-Chat

See links below to hear Cri-du-Chat (scroll ↓ the website for sounds) & to view image of simian crease

Abnormal Features

- Polydactyly – sometimes associated with lethal abnormalities
- Lethal abnormalities – lethal, but when?
  - Cystic Fibrosis (Caucasians)
  - Sickle Cell Anemia (African)
  - Trisomy 13 (Patau syndrome)
  - Trisomy 18 (Edwards' syndrome)

FYI see links below for video about Cri-du-Chat & for Atlas of congenital anomalies

Abnormal Features

- Lethal anomalies
  - Inoperable cardiac anomalies (acardia)
  - Potter's syndrome
  - Pulmonary hypoplasia – undeveloped lung(s)
  - Renal agenesis
  - Anencephaly
  - Lethal white disease (horses)

FYI see link below to view image of anencephaly

Abnormal Features

- Lethal anomalies – ethical & legal issues
  - Futility of efforts
  - Allocation of resources
  - End-of-life care for parents

Abnormal Features

- Gastroschisis: externalized , uncovered bowel
- Omphalocoele
  - Bowel covered with peritoneum
  - Associated with other abnormalities
- Spina bifida: exposed spinal cord
- Hydrocephaly: cerebral edema

See links below to view images of gastroschisis, spina bifida, & hydrocephaly

Physiologic Features

- Lung mechanics
  - TV = 7 mL/kg
  - FRC = 21 mL/kg
  - V_D = 5 mL/kg
  - Respiratory system compliance
    - Term newborn - 5 mL/cm H_20
    - Preterm Newborn - 3 mL/cm H_20
    - Adult – 100 mL/cm H_20

Physiologic Features

- Lung mechanics
  - High chest wall compliance
    - Decreased support of lung expansion by chest wall
    - Thoracic retractions: early sign of distress

See link below for video of retractions (16 sec)

Physiologic Features

- Airway Resistance
  - Term newborn → 70 cm H_2O/L/sec
  - Preterm newborn → 97 cm H_2O/L/sec
  - Adult → 2.5 cm H_2O/L/sec
- Inspiratory flow
  - Term newborn → 3-6 L/min
  - Adult → 30-60 L/min

Blood Gases

- Sample sources
  - Umbilical cord – partum
  - Umbilical artery catheter
  - Peripheral artery, e.g. brachial
  - Vein – pH & pCO_2 only
  - Capillary
    - Painful for patient
    - pH & pCO_2 only
    - Unreliable if patient is in shock

Blood Gases

- Hypoxia sources
  - Hypoxemia (decreased PO_2, SpO_2)
    - Anatomic shunts
    - Pulmonary shunts
  - Anemia - includes
    - Hb_{CO} from maternal smoking
    - Hb_{MET} from nitric oxide (NO)
  - Circulatory
    - Anatomic shunts
    - Shock

Blood Gases

- Acid-base disturbances
  - Respiratory acidemia
  - Respiratory alkalemia
  - Metabolic acidemia
    - Shock, sepsis
    - Diarrhea – loss of bicarbonate
    - Metabolic disorders, e.g. diabetes
  - Metabolic alkalemia
    - Diuretics
    - Gastric suctioning

Umbilical Arterial Gas Sea Level Norms

	20 Min	1 HR	4 HRS
pH	7.35	7.40	7.40
$PaCO_2$	35	30	35
PaO_2	50-65	50-65	65-70

Note: Shift in HbO_2 curve → infant p50 = 21 mm Hg

Blood Gases

- Oxygenation Index: calculated score
  - Used for all patient groups
  - Purposes
    - Predict outcomes
    - Guide management choices, e.g. ECMO
    - Compare outcomes among institutions, e.g. for benchmarking

FYI see link below to download article on oxygenation index (click on 'pdf' on website to download)

Blood Gases

- Oxygenation Index (OI)
  - Advantage over other indexes: takes mean airway pressure into account
  - Oxygen Index equation

$$OI = \frac{FiO_2 * MAP}{PaO2}$$

FYI see link below for an oxygen index calculator

Pulse Oximetry

- Purposes
  - Adjust FiO_2
    - Ensure adequate oxygenation
    - Prevent hyperoxia
  - Screening for ductal-dependant cardiac anomalies
  - Perfusion index from signal amplitude reflects illness severity
- Optimal range for SpO_2 for infants on O_2 therapy = 85% - 93%

TOSCA Monitor

- Made by Linde Medical Sensors
- Ear sensor with SpO_2 and transcutaneous pCO_2 ($P_{TC}CO_2$) measurement
- Found accurate and reliable by several studies

FYI see link below to view abstract of study on TOSCA

Neonatal Blood

- Fetal Hb
  - Greater affinity for O_2 than adult Hb - partial compensation for low fetal PaO_2 (<29 mm Hg)
  - Present with adult Hb for first year
- Initial CBC (term)
  - Hb = 16.5 – compensation for PaO_2
  - Hct = 50
  - WBC = 18,000

Neonatal Blood

- Immunoglobulins
  - IgG from mom while in utero
  - IgA from breast milk
  - Newborn starts developing own IgG post-natally
  - Increased IgM at birth → intrauterine infection

FYI see link below for more information on immunoglobulins

Weight/Gestational Age

- Gestational age – extremely low gestational age (ELGAN) - < 28 weeks
- Weight/GA categories
  - Appropriate for gestational age (AGA)
  - Small for gestational age (SGA)
  - Large for gestational age (LGA)
- Infants who are SGA show greater mortality, independent of gestational age

Weight Categories

	Weight
Moderately low (MLBW)	1,501 - 2,500 g
Very low (VLBW)	1,001 - 1,500 g
Extremely low (ELBW)	< 1,000 g

Review and Summary

- Apgar score: general health
- Ballard score: gestational age
- Silverman respiratory status index
- Critical care scores: CRIB, SNAPPE

Review and Summary

- Normal physical features
- Abnormal physical features
- Normal neurological response
- Cardiovascular assessment
- Normal physiologic features
  - Lung mechanics
  - Blood gases, pulse oximetry
- Weight/gestational age relationships

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