INTERPRETING NEONATAL LABS

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OBJECTIVES

- Identify value ranges for common neonatal lab tests
- Discuss blood gas values and interpretations with disease states
- Discuss common infection laboratory values
- Discuss basics of hematology with CBC interpretation

COMMON NEONATAL LABS

- Blood gases (ABG/VBG/CBG/cord gases)
- Complete metabolic panel (CMP), Basic metabolic panel (BMP)
- Complete blood count (CBC)
- Urinalysis
- Cultures
- Respiratory Viral Panel (RVP)
- Drug levels
- Thyroid studies
- State newborn screens
- CSF studies

Table 13-1

Common Laboratory Tests in the NICU by System

Fluids Electrolytes Nutrition	Respiratory	Cardiac	GI	Renal	Endocrine/Metabolic	Neurologic	Hematologic	Other
Electrolytes (serum)	Blood gas	Iso-enzymes	Alkaline phosphatase	BUN (serum)	Glucose	Phenobarbital level	CBC with differential	Chromosome studies
Calcium (serum)	pH	Digoxin level	Triglyceride levels	Creatinine (serum)	Thyroxine level Thyroid-stimulating hormone level	Dilantin level	Hct/Hgb	Bilirubin Total/indirect/direct
Magnesium (serum)	$Paco_2$		AST (SGOT)	Specific gravity	Cortisol level	Ammonia (serum)	Platelet count Platelet antibody	CRP
Phosphorus (serum)	Pao_2		ALT (SGPT)	Urine sodium	Insulin level	Amino acid (serum)	Reticulocyte count	Drug levels
Alkaline phosphatase	Bicarbonate (HCO_3^-)		GGT (GGTP)	Urine potassium	Growth hormone level	Amino acid (urine)	Direct Coombs' test/ DAT	Urine/meconium/ cordtoxicology screen
Glucose (serum)	Base excess		Bilirubin (total and direct)	Urine osmolality	Testosterone level	Organic acids (urine)	Blood type and Rh	Culture and sensitivity (all sources)
Vitamin levels	Theophylline level		Ammonia (serum)		Aldosterone (serum and urine) level	Glycine (serum and CSF)	G6PD	RPR/VDRL
Serum osmolality	Caffeine level		α_1-antitrypsin	Uric acid (serum)	17-hydroxy corticosteroids	Pyridoxine level	Sedimentation rate	Occult blood (fecal)
Albumin (serum)	Cultures (tracheal/ sputum)		Trypsin (stool)	Urinalysis	Parathyroid hormone level	Lactic acid/ lactate level	Folic acid	PCR (serum)
Total protein			Pyridoxine level	Urine culture/ sensitivity	State blood spot screening		Fibrinogen PT PTT Immunoglobulins Methemoglobin	

ALT (SGPT), Alanine aminotransferase (serum glutamic-pyruvic transaminase); *AST (SGOT)*, aspartate aminotransferase (serum glutamic-oxaloacetic transaminase); *BUN*, blood urea nitrogen; *CBC*, complete blood count; *CRP*, C-reactive protein; *CSF*, cerebrospinal fluid; *DAT*, direct antiglobulin test; *GI*, gastrointestinal; *GGT (GGTP)*, γ-glutamyltransferase (γ-glutamyl transpeptidase); *G6PD*, glucose-6-phosphate dehydrogenase; *Hct*, hematocrit; *Hgb*, hemoglobin; *NICU*, neonatal intensive care unit; *PCR*, polymerase chain reaction; *PT*, prothrombin time; *PTT*, partial thromboplastin time; *RPR*, rapid plasma reagin; *VDRL*, venereal disease research laboratory.

Box 13-1

Laboratory Interpretation: Is It Reliable? Is It Believable?

Yes	No
Implement an appropriate clinical intervention, if needed.	Consider repeating the laboratory test when the appropriate correction is made.
Consider repeating the laboratory test if the clinical status continues to warrant a laboratory test.	

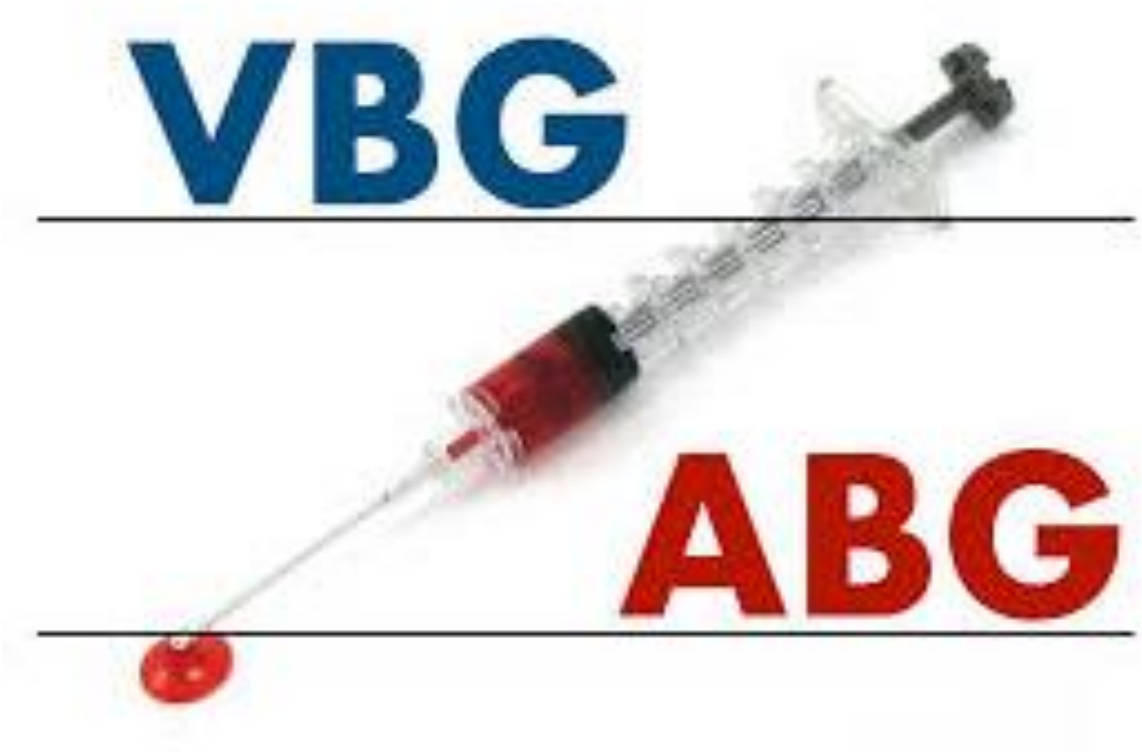
Result Too Low	Result Too High
Is the sample diluted?	Does the blood gas need to be temperature corrected (as with neuroprotective hypothermia therapy)?
Was the sample handled correctly?	Was the laboratory specimen drawn too early?
Was the timing of the test an issue?	
Was medical therapy not implemented or inadequate?	
Was the specimen site condition a factor?	
Was the point-of-care testing (POCT) device calibrated?	
Was there interference from a past medical therapy?	
Was the sample handled correctly?	
Was medical therapy not implemented or inadequate?	

LABORATORY INTERPRETATION

The goal of laboratory testing is to diagnose and guide management of disease

Careful laboratory data interpretation is essential in providing accurate therapeutic interventions

Does the lab result match the clinical picture?



BLOOD GAS

- Most common laboratory measurement to assess the ventilation/acid-base balance/oxygenation of a neonate.
- Sample types: venous, arterial, capillary
- Sample methods:
- Venous: venous puncture/umbilical vein draw
  - Capillary: capillary sampling (heel stick)
  - Arterial: umbilical artery draw/arterial puncture/peripheral arterial line
  - Arterial preferred sample as it has a more accurate measurement of the PaO2

Cord gases: arterial and venous (arterial more accurate picture of infant condition)

BLOOD GAS-PH

Normal arterial blood gas ph: 7.35-7.45

Monitor acid-base balance: normal cell function is dependent on regulation of the hydrogen ion (H+) concentration in the blood.

Changes in ph indicate a change in the acid-base balance of the infant = change in cellular metabolism/function

BUFFER SYSTEMS: Ways to regulate (H+)

1. Exhalation of carbon dioxide (CO2) via the lungs
2. Excretion of H+ by the kidney/reabsorption of HCO3-

Acidosis is ph <7.35

Alkalosis is ph >7.45

The ph value is going to give you acid or basic state but the other values can lead you to why!

BLOOD GAS- PCO2

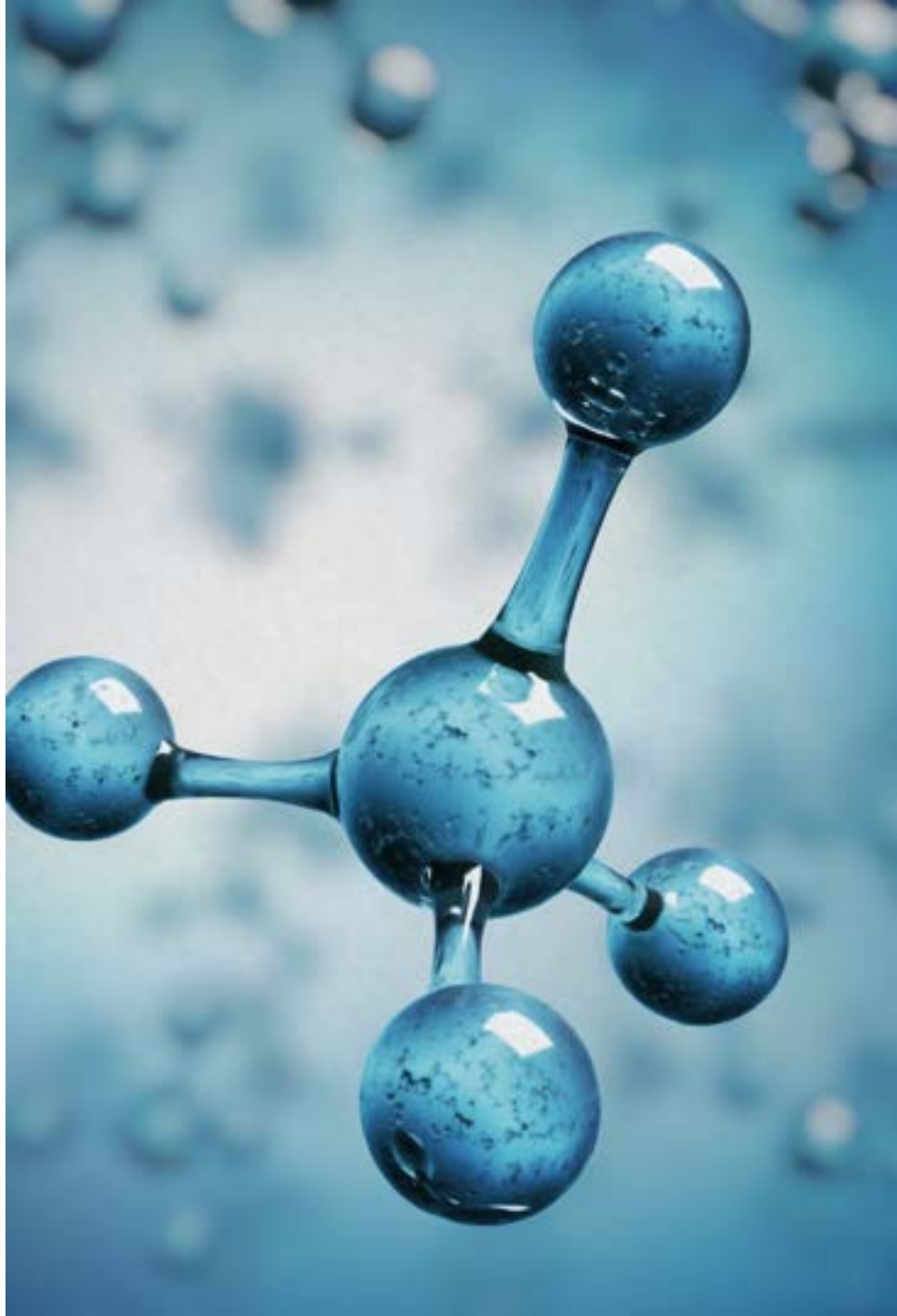
Carbon dioxide (CO2)-waste product of cellular metabolism

Three ways carbon dioxide is transported in the blood stream from the peripheral tissues and back to the lungs

1. **dissolved gas (pCO2)** 2. bicarbonate 3. carbaminohemoglobin bound to hemoglobin (and other proteins)

Moves via diffusion from peripheral tissues to blood stream

Most CO2 combines with H20 in the RBC to form carbonic acid which immediately dissociates into bicarbonate ions, thus most of the bodies CO2 is transported via bicarbonate



BLOOD GAS-PAO2

Normal arterial level: 50-80 mm Hg ⇩

Assessing **Hypoxemia** (oxygen deficiency in arterial blood mostly due to respiratory conditions)

Oxygen enters lungs during inspiration & diffuses across alveolar-capillary membrane

Oxygen (O2) transported to the tissues either as

dissolved in the blood plasma (3%) and reported as partial pressure of oxygen (PaO2)

OR

Bound to hemoglobin (97%) reported as the O2 saturation (SpO2)

As the amount of O2 is increased in the blood (higher PaO2) hemoglobin (that is available) becomes more saturated

Affecting factors: fetal hemoglobin (affinity for O2), high O2 consumption states (sepsis, increased temperature, decreased ph)

BLOOD GAS-HCO3

Normal arterial level of HCO3-: 22-26 mEq/L

HCO3- = Bicarbonate: compound capable of accepting H+ (buffer)

Amount of HCO3- in the body is controlled by the kidneys = kidneys reabsorb

Rate of neonate ability to reabsorb HCO3- is 1/3 of an adults

Primary indicator of metabolic acid-base imbalances

In normal circumstances: kidneys retain or reabsorb HCO3- based on ph and CO2 in plasma.

- Plasma more acidotic more HCO3- is recovered and reabsorbed by tubular cells
- Plasma alkalotic less HCO3- is retained or reabsorbed.

Decrease in HCO3- = acidosis/Increase = alkalosis

WHAT'S A BUFFER?

Examples: HCO3-(bicarbonate, Plasma proteins, Hemoglobin

- First line of defense against excess H+ concentration in the blood.
- Acid in an H+ donor, Base is an H+ receptor
- Bicarbonate is major buffer, teams with H+ to form carbonic acid, which dissociates into water and CO2 to be eliminated

BLOOD GAS-BASE DEFICIT/EXCESS

Normal arterial base excess: -2 - +2

Base excess= calculated value that considers the amount of HCO3- generation/retention by the kidneys (metabolic clue).

Answers question: How much a change in PaCO2 will cause a change in HCO3-

Base excess measures moles of acid needed to return one liter of blood to pH of 7.40

Base deficit are the moles of acid needing to be excreted to return…..

+ number indicates alkalosis

- number indicates acidosis

NORMAL ARTERIAL BLOOD GAS VALUES

pH	7.35-7.45
PaCO2	35-45 mm Hg
PaO2	80-100 mmHg
HCO3-	22-26 mEq/L
Base excess	-2 - +2

BLOOD GASES-ANALYSIS

Respiratory acidosis (↓ pH)	PCO2 >45
Respiratory alkalosis (↑ pH)	PCO2 <35
Metabolic acidosis (↓ pH)	HCO3- <22/base deficit
Metabolic alkalosis (↑ pH)	HCO3- >26/base excess

AT BIRTH WHAT AFFECTS BLOOD GAS VALUES?

- Respiratory distress syndrome (surfactant insufficiency)
- Meconium aspiration syndrome
- Chorioamnionitis
- Maternal magnesium/general anesthesia
- Congenital heart defects
- Multiple congenital anomalies
- HIE (hypoxic-ischemic encephalopathy)
- Pneumothorax

Table 26.2

Causes of Acidosis and Alkalosis

Cause	Mechanism
Respiratory Acidosis (↑ $Paco_2$, ↓ pH)	
CNS depression	Maternal narcotics during labor, asphyxia, intracranial hemorrhage, neuromuscular disorder, CNS dysmaturity (apnea of prematurity)
Decreased ventilation–perfusion ratio	Obstructed airway, meconium aspiration, choanal atresia
Decreased lung compliance	Respiratory distress syndrome, pulmonary insufficiency, diaphragmatic hernia
Injury to the thorax	Phrenic nerve paralysis, pneumothorax
Metabolic Acidosis (↓ HCO_3^-, pH, and Base Deficit [Negative Value])	
Decreased tissue perfusion	Increased lactic acid production
Sepsis, congestive heart failure	Increased lactic acid production
Renal failure	Increased organic acids
Renal tubular acidosis	Renal loss of base
Diarrhea	Gastrointestinal loss of base
Respiratory Alkalosis (↓ $Paco_2$, ↑ pH)	
Iatrogenic	Excessive mechanical ventilation
Hypoxemia	Increase in alveolar ventilation
CNS irritation (pain)	Increase in alveolar ventilation
Metabolic Alkalosis (↑ HCO_3^-, pH, and Base Excess [Positive Value])	
Gastric suction	Loss of acid
Vomiting	Loss of acid
Diuretic therapy	Renal losses of H^+ ion
Iatrogenic	Administration of HCO_3^- (base added)

CNS, Central nervous system.

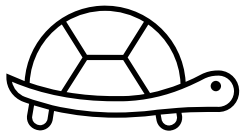
COMPENSATION

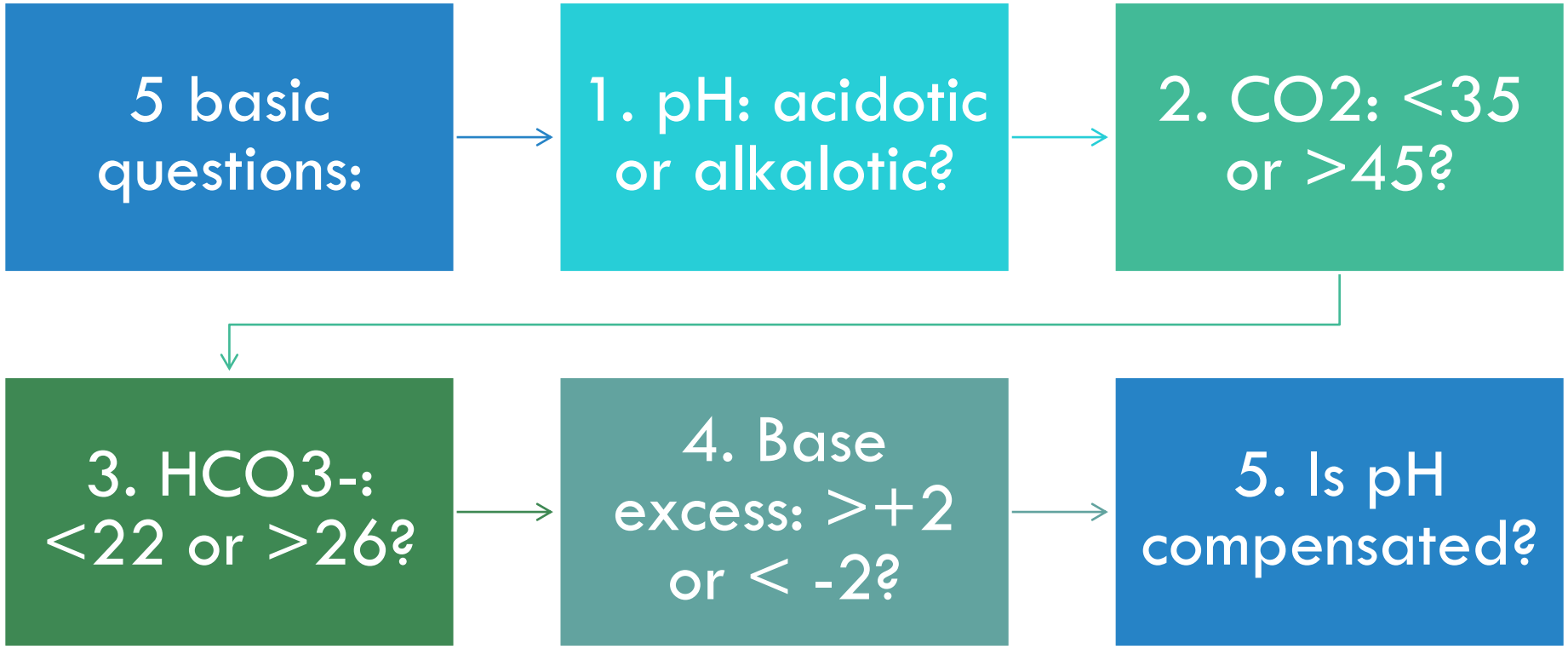
Cause of acid/base imbalance is either respiratory or metabolic

Compensation= Body attempt at maintaining a normal pH level/maintain homeostasis

Respiratory system and kidneys working together to maintain pH in normal range.

Respiratory system = FAST

Kidneys = 



BLOOD GAS ANALYSIS

ABG Quick Interpretation

Parameter	Acidosis	Normal	Alkalosis	Reflects
pH	< 7.35	7.35-7.45	> 7.45	Acid/Base Status of Body
pCO_2	> 45	35-45	< 35	Respiratory Component
HCO_3	< 22	22-26	> 26	Metabolic Component

Facts: Body will not overcompensate when it comes to acid/base balance so:

- pH midpoint is 7.4
- If pH on report is < 7.4 = original problem was acidosis in nature
- If pH on report is > 7.4 = original problem was alkalosis in nature

Examples:

1. pCO_2 is High and pH is 7.37 = compensated Respiratory Acidosis because in spite of high pCO_2 which would indicate Acidosis the pH is within normal range indicating that the metabolic component has kicked in and caused pH to shift more towards the midpoint of 7.4
   and therefore compensated for the respiratory acidosis.
2. pH is 7.44 and the HCO_3 is 33 it is a Metabolic Alkalosis with Respiratory Compensation bringing the pH back to WNL but not past midpoint.

pH	pCO_2	HCO_3	Interpretation*
↑	↓	WNL	Respiratory Alkalosis
↑	WNL	↑	Metabolic Alkalosis
↓	↑	WNL	Respiratory Acidosis
↓	WNL	↓	Metabolic Acidosis
< 7.4	↑	↑	Compensated Resp. Acidosis
> 7.4	↓	↓	Compensated Resp. Alkalosis
< 7.4	↓	↓	Compensated Meta. Acidosis
> 7.4	↑	↑	Compensated Meta. Alkalosis

*Where compensation is not involved you can look at the arrows:

- Arrows are in same direction = metabolic conditions
- Arrows in opposite direction = respiratory conditions

BLOOD GAS ANALYSIS PRACTICE

Uncompensated Respiratory Acidosis

ph 7.22

PCO2 65

PaO2 47

HCO3 22

Base deficit –6.3

Uncompensated Metabolic Acidosis

ph 7.18

PCO2 50

PaO2 68

HCO3 15

Base deficit -8.4

BLOOD GAS ANALYSIS PRACTICE

Compensated respiratory acidosis

ph 7.36

PCO2 66

PaO2 54

HCO3 32

Base excess +4.5

Mixed respiratory/metabolic acidosis

Ph 6.81

PCO2 97

PaO2 23

HCO3 15

Base deficit –27

BLOOD GAS ANALYSIS PRACTICE

Uncompensated Mixed acidosis

ph 7.22

pCO2 78

PaO2 45

HCO3 17

Base deficit -6.7

Uncompensated respiratory acidosis

ph 7.17

PCO2 84

PaO2 48

HCO3 22

Base deficit -7

COMPLETE METABOLIC PANEL

Blood sample test that measures 14 different substances in the blood. It provides important information about the body's chemical balance and metabolism

- Glucose
- Sodium
- Potassium
- Chloride
- Calcium

Phosphorus & Magnesium

CO2/Anion Gap

BUN

Creatinine

Total Protein/Albumin/Globulin

Alkaline Phosphatase

ALT (SGPT)

AST (SGOT)

Magnesium/Phosphorus

COMPLETE METABOLIC PANEL-TCO2

Most of the body's CO2 (cellular waste) is in the form of HCO3 (bicarbonate)

Bicarbonate is a compound with the ability to accept H+, thus a buffer or base.

CO2 on the CMP is a measure of Bicarbonate as an indicator of the level of CO2 in your body

The test measures all types of carbon dioxide in your blood: bicarbonate, carbonic acid, and dissolved CO2.

BLOOD GAS- PCO2

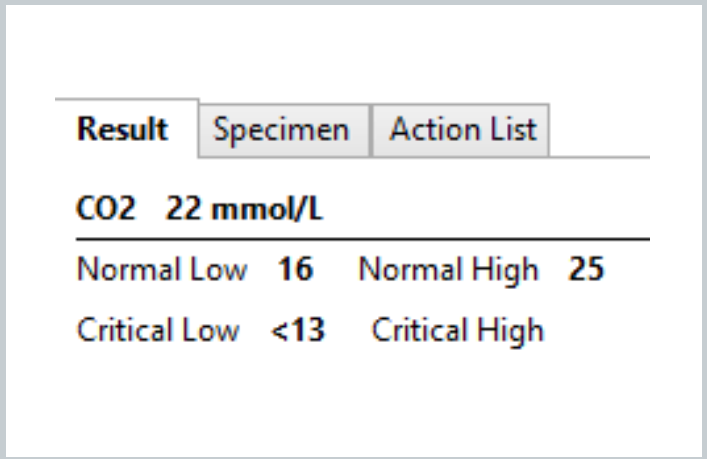
Carbon dioxide (CO2)-waste product of cellular metabolism

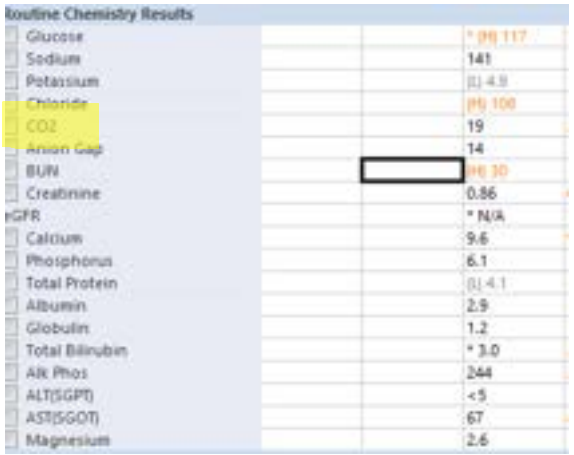
Three ways carbon dioxide is transported in the blood stream from the peripheral tissues and back to the lungs

1. dissolved gas (pCO2) 2. bicarbonate 3. carbaminohemoglobin bound to hemoglobin (and other proteins)

Moves via diffusion from peripheral tissues to blood stream

Most CO2 combines with H20 in the RBC to form carbonic acid which immediately dissociates into bicarbonate, thus most of the bodies CO2 is transported via bicarbonate





Anion Gap 12 mmol/L

Normal Low 7 Normal High 16

Anion Gap 12 mmol/L

Normal Low 7 Normal High 16

Albumin 3.0 g/dL

Normal Low 2.9 Normal High 5.5

Result | Specimen | Action List

Total Protein 4.7 g/dL (LOW)

Normal Low 5.4 Normal High 7.4

Anion gap: The anion gap is defined as serum sodium (Na) concentration minus the sum of serum chloride (Cl^-) and serum bicarbonate (HCO_3^-) concentrations. (math equation points to negative to positive gap and certain physiologic conditions)

Total protein: This is a measurement of the total amount of albumin and globulins, which are proteins in your blood.

Albumin: This is a protein that your liver makes. It transports important substances through your bloodstream and keeps fluid from leaking out of your blood vessels.

Globulin: a group of proteins called globulins in blood serum. Serum is the liquid part of blood.

COMPLETE METABOLIC PANEL

COMPLETE METABOLIC PANEL

Alkaline phosphatase: is an enzyme that's found throughout your body. ALP blood tests measure the level of ALP in your blood that comes from liver and bones.

Blood urea nitrogen (BUN): This is a measurement of urea nitrogen, which is a waste product that your kidneys help remove from the bloodstream.

Creatinine: This is a byproduct of muscle activity. It's a waste product that your kidneys filter and remove from your blood.

BUN 21 mg/dL	Alk Phos 221 U/L	Creatinine 0.50 mg/dL
Normal Low 6 Normal High 22	Normal Low 70 Normal High 350	Normal Low 0.50 Normal High 1.20

ALT 9 U/L

Normal Low **0** Normal High **40**

AST 32 U/L

Normal Low **15** Normal High **120**

Phosphorus 4.1 mg/dL (LOW)

Normal Low **4.8** Normal High **8.2**

Magnesium 2.1 mg/dL

Normal Low **1.7** Normal High **2.6**

Alanine transaminase (ALT) is an enzyme that mainly exists in your liver

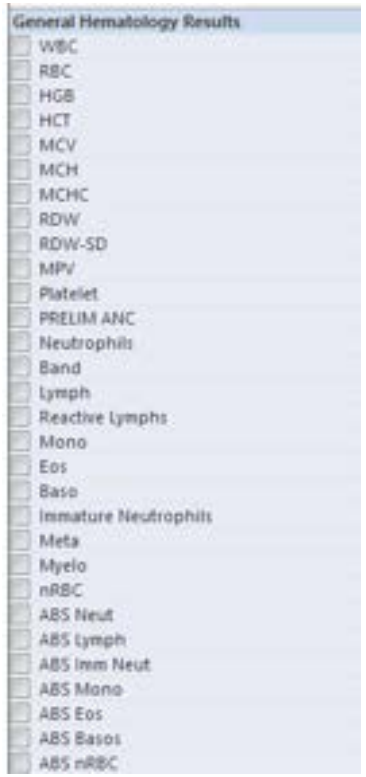
Aspartate transferase (AST) is an enzyme that's found in your liver, heart, pancreas, muscles and other tissues in your body

Magnesium/Phosphorus: bone health, checked with premature infants for bone/metabolic health

COMPLETE METABOLIC PANEL

AMMONIA

- Produced from the deamination of amino acids during protein metabolism and is the byproduct of bacteria protein breakdown.
- Metabolized by the liver
- Elevated in liver failure/acute or chronic liver disease
- Elevated in inborn errors of metabolism
- Normal values 90-150 mcg/dL



COMPLETE BLOOD COUNT

A CBC does many tests to measure and study red blood cells, white blood cells and platelets.

- **Red blood cells** carry oxygen throughout the body.
- **White blood cells** are part of your immune system. They help your body fight infection.
- **Platelets** help your body clot

CBC without differential counts the total number of white blood cells.

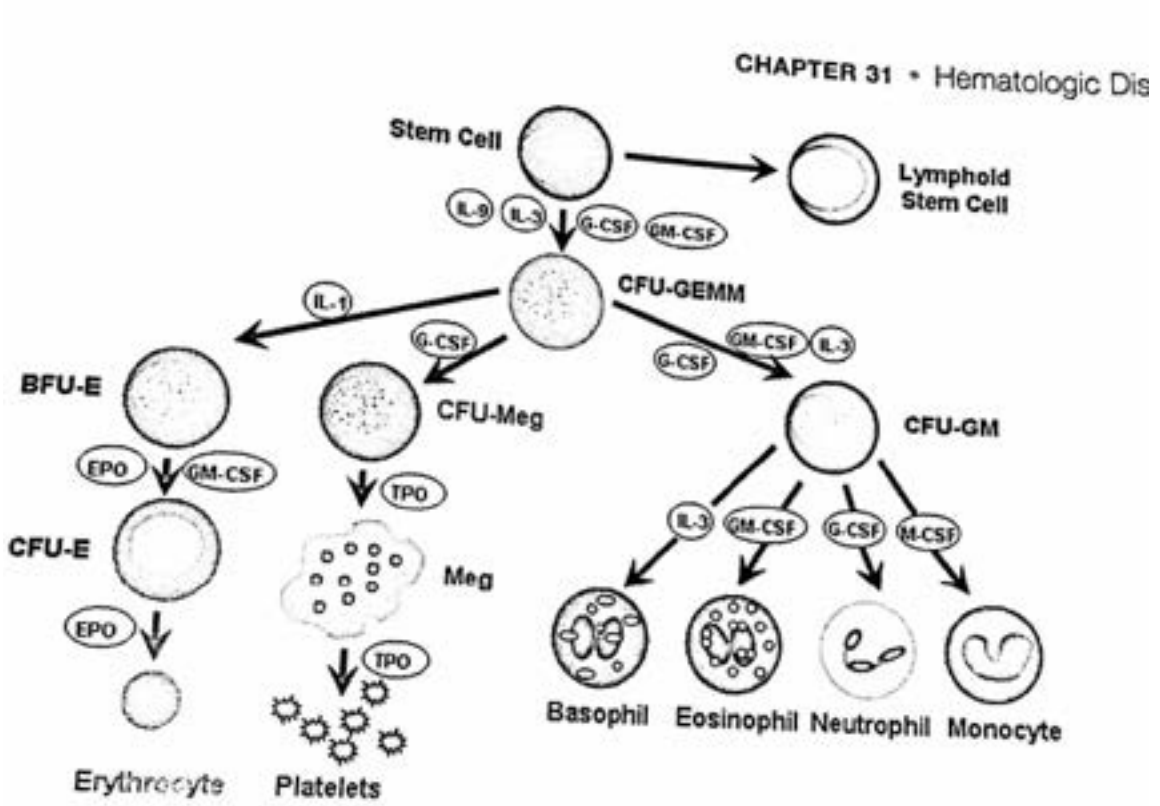
CBC with differential. There are five kinds of white blood cells. The differential looks at how many of each kind of white blood cell you have.

Hemoglobin tests measure hemoglobin, the protein in red blood cells that carries oxygen.

Hematocrit describes the concentration of red blood cells in your blood

HEMATOPOIESIS

Formation, production, maintenance of blood cells
Occurs in the bone marrow



Hematopoiesis and selected growth factors. *BFU-E*, Burst-forming unit, erythroid; *CFU-E* rming unit–erythroid; *CFU-GEMM*, colony-forming unit–granulocyte, erythrocyte, monc ophage; *CFU-GM*, colony-forming unit–granulocyte-macrophage; *CFU-Meg*, colony-formin karyocyte; *EPO*, erythropoietin; *G-CSF*, granulocyte colony-stimulating factor; *GM-CSF* e–macrophage colony-stimulating factor; *IL-1*, interleukin-1; *IL-3*, interleukin-3; *IL-9*, inte *M-CSF*, macrophage colony-stimulating factor; *Meg*, megakaryocyte; *TPO*, thrombopoieti rom Israels, L.G., & Israels, S. J. [2002]. *Mechanisms in hematology* [3rd ed., p. 402]. Toront re Health Sciences.)

COMPLETE BLOOD COUNT

Erythropoiesis: production of erythrocytes (RBCs)

- Regulated by the hormone Erythropoietin-regulated by hypoxia sensing mechanisms in the kidneys

RBC: oxygen transport to tissues, CO2 transport

RBC count: number of circulating mature RBC's per cubic millimeter

RBC lifespan for term infant = 60-70 days, preterm infant =35-50 days

nRBC: nucleated RBC are circulating immature RBCs

increased number can indicate oxidative (cellular) stress

RBC indicies: measure of RBC size and hemoglobin content used for designation of anemias

CBC-RED CELL INDICES

Mean corpuscular volume (MCV): average size and volume of a single RBC.

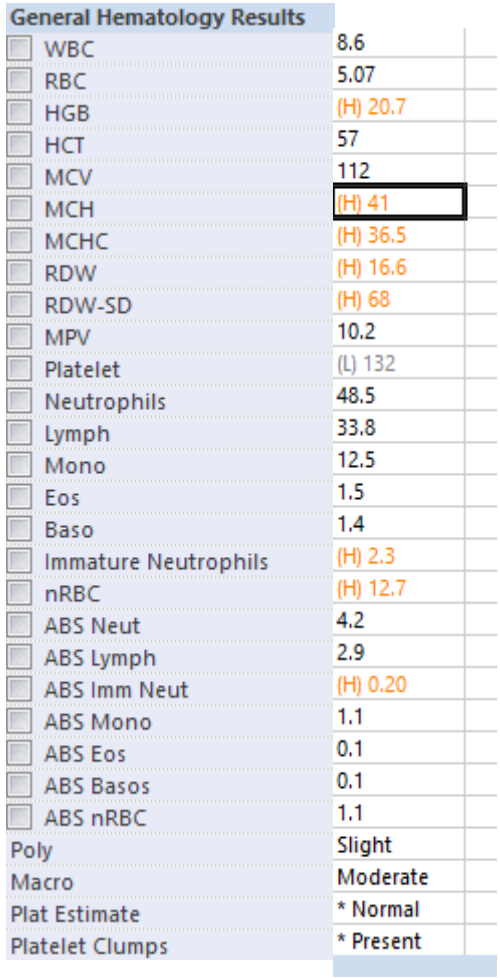
Mean corpuscular hemoglobin (MCH): average amount (by weight) of hemoglobin in each RBC

Mean corpuscular hemoglobin concentration (MCHC): average concentration of hemoglobin per single RBC

Red blood cell distribution width (RDW): measures how varied RBC are in size and volume.

Mean platelet volume (MPV): measures the average size of your platelets.

All help define different anemias



General Hematology Results	
WBC	8.6
RBC	5.07
HGB	(H) 20.7
HCT	57
MCV	112
MCH	(H) 41
MCHC	(H) 36.5
RDW	(H) 16.6
RDW-SD	(H) 68
MPV	10.2
Platelet	(L) 132
Neutrophils	48.5
Lymph	33.8
Mono	12.5
Eos	1.5
Baso	1.4
Immature Neutrophils	(H) 2.3
nRBC	(H) 12.7
ABS Neut	4.2
ABS Lymph	2.9
ABS Imm Neut	(H) 0.20
ABS Mono	1.1
ABS Eos	0.1
ABS Basos	0.1
ABS nRBC	1.1
Poly	Slight
Macro	Moderate
Plat Estimate	* Normal
Platelet Clumps	* Present

COMPLETE BLOOD COUNT

WBC count: number of circulating WBC's per cubic millimeter

Platelets: small nonnucleated disk-shaped cells aid in hemostasis, coagulation, and thrombus formation

Hemoglobin: major iron-containing component of the RBCs

- Carries oxygen from lungs to tissue cells

Hematocrit: percentage of RBCs in a unit volume of blood

Absolute Neutrophil count: how many neutrophils (infection fighting WBCs) are in a sample of your blood.

Reticulocytes: immature RBC

- In absence of stress mature 1-2 days in the bone marrow and 1 more day in circulation before fully mature

HCT/HGB (ANEMIA)

Low hemoglobin concentration and/or decreased number of RBC (HCT)=diminished oxygen carrying capacity of the blood and level of oxygen available to the tissues.

3 main cause at birth:

1. Blood loss
2. RBC shorted life span
3. Underproduction of erythrocytes

HCT/HGB (ANEMIA)

Hemorrhage (blood loss)	Shortened RBC survival	Under production of RBC
Fetal-maternal (acute or chronic) Twin to twin transfusion (mono/mono) Placenta/cord issues Internal hemorrhage: IVH or ICH, organ rupture, pulmonary bleed External: phlebotomy, iatrogenic	Hemolysis: ABO incompatibility, Rh sensitization, enzymatic defects (ex. G6PD), hemoglobin disorders (ex. A-thalassemia)	PREMATURITY-considered physiologic/naturally occurring Decreased erythropoietin production

POLYCYTHEMIA
(100,000 TO 400,000/ MM³ FIRST 10 DAYS OF LIFE)

- Excess of circulating RBCs
  - Hct > 65% (venous sample)
  - Impairs peripheral circulation r/t blood viscosity
    - Can lead to reduction of blood flow to organs
- Active Polycythemia
  - Excess production of RBCs
- Passive Polycythemia
  - Transfusions
  - Twin to twin
    - Monochorionic monoamniotic
    - Blood is exchanged unequally between the fetuses with the donor twin being anemic and the recipient twin polycythemia
  - Delayed cord clamping
  - Fetal stress

THROMBOCYTOPENIA (< 150,000)

- Caused by decreased production, increased destruction, sequestration or loss
- **Most common bleeding disorder in newborn**
- Bacterial/viral infections/NEC
- Hypoxia/birth asphyxia
- Disseminated Intravascular Coagulation (DIC)
- Persistent Pulmonary Hypertension of Newborn (PPHN)
- Polycythemia
- Congenital infections
- Congenital syndromes (Down syndrome)
- Preeclampsia-falsely low
- Giant hemangiomas
- Late indicator of sepsis
- Watch for wide-spread petechia

TRANSFUSION GUIDELINES

Transfusion Criteria

Post-natal Age	Respiratory Support* Hct (Hgb)	No Respiratory Support Hct (Hgb)
0 through 6 Days of life	32 (11.0)	29 (10.0)
7 through 13 days of life	29 (10.0)	25 (8.5)
14 days of life or greater	25 (8.5)	21 (7.0)

**Respiratory support was defined as mechanical ventilation, continuous positive airway pressure (CPAP), FiO_2 >0.35, or high flow nasal cannula of 1 liter/minute or greater (includes room air nasal cannula of 1 liter/min or more).*

Transfusion Criteria

	Population	Threshold
Thrombocytopenia	Stable preterm or term infant	25,000/µL
	ELBW (BW<1000g) in the first week of life	25,000/µL
	Clinically unstable* infant	25,000/µL
	Immediately pre-/post-op	50,000/µL
	ECMO or active bleeding	100,000/µL
Normal platelet count	Massive transfusion protocol initiated	
	Active bleeding with known qualitative platelet defect	

*Clinically unstable defined as evidence of sepsis, necrotizing enterocolitis, intracranial hemorrhage, hypotension requiring vasopressors, or other hemodynamic instability

COMPLETE BLOOD COUNT-WBC TYPES

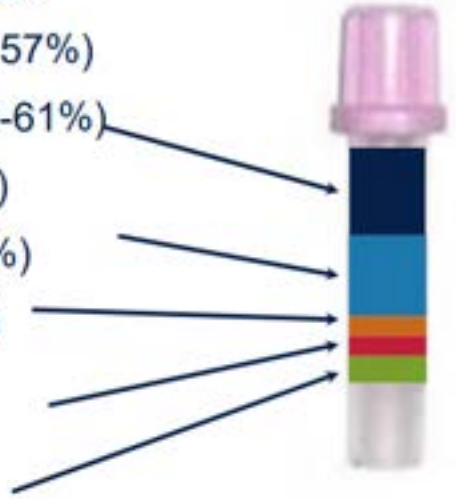
- Mature in the bone marrow and lymphatic tissue
- WBC's leave circulation to enter the tissues where they function as part of the immunologic system in reaction to foreign proteins.
- WBCs=granulocytes, lymphoctyes, and monocytes

Granulocytes	**Lymphocytes-immune response**	**Monocytes-** macrophages
Basophils Eosinophils Neutrophils	Thymus derived T cells Bone marrow derived B cells	Circulating immature macrophages

COMPLETE BLOOD COUNT

CBC-White Blood Cells with differential

- Protect against infective organisms and foreign substances
- Leukocytosis and leukopenia can be problematic
- 5 main types of WBCs
  - **Neutrophils** (31-57%)
  - Lymphocytes (35-61%)
  - Monocytes(4-7%)
  - Eosinophils (2-4%)
  - Basophils (0-1%)



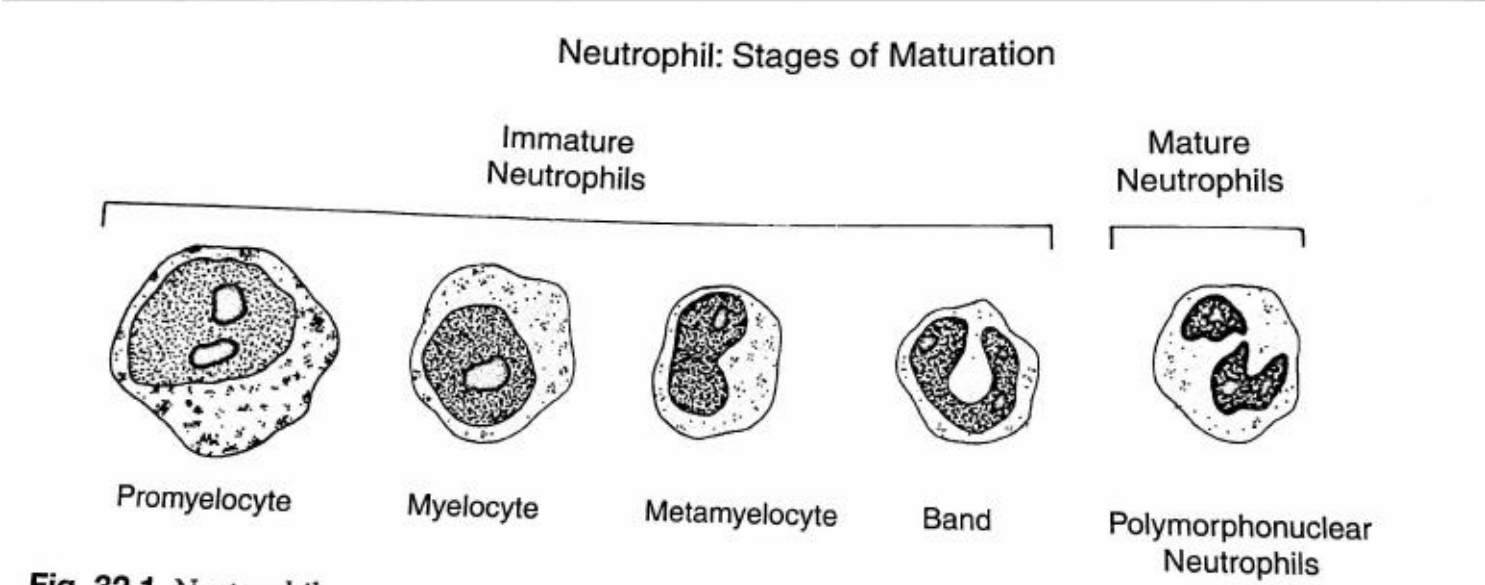


Fig. 32.1 Neutrophils represent a percentage of the total white blood cell count and are reported as the differential on a complete blood cell count.

NEUTROPHIL: STAGES OF MATURATION

White blood cell count (WBC): 5000-30,000

Not always good indicator of infection

Neutrophilia: inconsistent response to infection, often normal with serious infection

Neutropenia: risk for infection based on not enough infection fighting cells. <1800cells/mm^3?

COMPLETE BLOOD COUNT

How do you know its infection?

- Early onset <72 hours
  - From maternal origin through vertical transmission through amniotic fluid or from bacteria from a vaginal delivery
- Most common group B streptococci/e coli
- We follow maternal risk factors (GBS status, gestational age, chorioamnionitis, prolonged rupture of membranes.
- Vital sign trends and clinical status with WBC value
- I/T ratios (immature-total): increase in the I/T ratio is known as a left shift, reflects an increase in immature neutrophils circulating.
  - Best served as a negative predictive value-if its normal it's probably not infection

DISSEMINATED INTRAVASCULAR COAGULATION (DIC) PANEL

Acquired hemorrhagic disorder associated with an underlying disease manifested as uncontrolled activation of coagulation and fibrinolysis.

- Consumption of clotting factors through cascade that starts with damaged or diseased tissue
- Microvascular thrombosis that this lyses and increases bleeding

Values include:

- Partial thrombin (PT), Partial thrombin time (PTT), Thrombin Time, Fibrinogen, D-dimer, Platelet Count and Schistocyte DIC-not on neonatal panel
- Clotting times are lengthened, Fibrinogen is low (<200), D-dimer elevated=clots being lysed, platelet count is low
- Aggressively treat underlying disease/condition
- Replaced clotting factors: PRBC, Fresh Frozen Plasma (all clotting factors), Cryoprecipitate (fibrinogen, factor VIII), platelets

C-REACTIVE PROTEIN (CRP)

- Acute phase reactant synthesized in the liver
- Appears in blood during an acute inflammatory process/associated with tissue injury
- Most recent research does not support the use of CRP for identifying infections
- Not specific for infection-rules out the false negatives
- Not sensitive for infection-just because it's elevated doesn't mean it's infection
- Change in practice is hard!

LACTATE

- Evaluates lactic acid
- Measures perfusion and adequate oxygen function to the cells
- Increased when hypoxia present = tissue injury/necrosis
- Increased with sepsis r/t anaerobic metabolism
- CHD and sepsis

INFECTION RELATED LAB

Cerebral Spinal Fluid

Obtained via lumbar puncture or ventricular tap/reservoir tap

Bacterial/Viral meningitis

Cell count, Glucose, Protein, Gram stain/culture and/or viral studies

Urine

Urine culture and/or urine analysis

Culture obtained via straight catheter specimen or indwelling foley

- CFU >50,000

Higher incidence in longer LOS

Urine analysis obtained with bag

CMV testing (urine/CSF)

INFECTION RELATED LAB

Respiratory Viral Panel (RVP)

Nasal swab

Includes- COVID-19, Influenza A, B, RSV, Adenovirus, Human Metapneumovirus, Parainfluenza Viruses 1-4, and Rhinovirus

Droplet isolation while waiting for results

If positive isolation contiues based on pathogen identified

Blood culture

Obtained sterilely via indwelling line or peripheral puncture

Ideally 1-2ml for best bacterial count

99% positive by 36-48H

Repeat until negative culture is obtained

Consider peripheral site if indwelling line draw is positive

OTHER

Therapeutic drug monitoring

- antibiotic peak/troughs/random levels
- Phenobarbital level (therapeutic around 40mcg/ml)

Anti Xa level: used to guide anticoagulation treatment ie) Lovenox

THYROID STUDIES

- Hypothyroidism: Permanent (congenital) or acquired (transient)
- TSH
  - Stimulates thyroid to produce T4 and T3
- T4
  - Needed for pre and postnatal brain maturation

Thyroid hormones responsible for almost every tissue in the body

CONGENITAL HYPOTHYROIDISM

- Most preventable and treatable cause of mental retardation – symptoms don't often present until 6 weeks of age
  - Deficiency in thyroid hormone
  - Tested for on state newborn screens
- TSH – thyroid stimulating hormone used to predict congenital hypothyroidism
- T4 – tests newborns for hypothalamic-pituitary-hypothyroidism
- Treatment – thyroxine

NEWBORN STATE SCREENS

60 conditions screened: Rare genetic/metabolic/endocrine disorders

Required by law for every baby born in Nebraska to be screened

Healthy term infants: collected between 24-48 hours old

NICU: #1: drawn on admission #2: drawn 48-72 hours, #3: 28 days of life (if <2kg)

Why important?

- Conditions usually don't have signs or symptoms recognizable until internal damage is done
- Conditions are treatable, early treatment can prevent serious problems

SCREENING: false positives are common, if positive result specific testing for condition recommended or repeat dried blood spot card

Nebraska | Newborn Screening (hrsa.gov)

http://dhhs.ne.gov/Newborn%20Screening/2018%20Practitioners%20Manual%205th%20Edition.pdf

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