AACN CCRN (Neonatal) - Quiz Questions with Answers

IA. Cardiovascular

1.

Which of the following is NOT a cause of hypovolemic shock for neonates?

Congenital heart lesion with subsequent myocardial failure

Umbilical cord rupture at birth

Postnatal intracranial hemorrhage

Erythroblastosis fetalis

Correct answer: Congenital heart lesion with subsequent myocardial failure

*There is a large differential for blood loss in neonates, which (if profound) can lead to hypovolemic shock. Blood loss from placental abnormalities (**umbilical cord rupture at birth**, abruptio placentae, placenta previa, twin-to-twin transfusion syndrome), acute blood loss postnatally (such as pulmonary or **intracranial hemorrhage**), acute or chronic blood loss postsurgically, and plasma and fluid losses are all causes of hypovolemic shock.*

***Erythroblastosis fetalis** is an alloimmune condition that develops when maternal IgG antibodies pass through the placenta to the fetus and attack antigens on the red blood cells in the fetal circulation (breaking down and destroying cells). The fetus can develop anemia and reticulocytosis.*

*Cardiogenic shock can be caused by myocardial failure due to severe hypoxemia, hypoglycemia, hypocalcemia, or acidosis. Examples of cardiogenic shock include **congenital heart lesions**, cardiac arrhythmias (e.g., sustained SVTs, complete atrioventricular block), cardiac function restriction (tamponade, tension pneumothorax, excessive levels of ventilatory distending pressures), and myocarditis (which is often associated with sepsis).*

2.

A large ventricular septal defect (VSD) in a neonate results in which of the following?

Left-to-right shunting

Right-to-left shunting

Decreased pulmonary circulation

A harsh diastolic murmur heard over the lower left sternal border

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Correct answer: Left-to-right shunting

VSDs are the most common congenital heart defect. At 2 per 1,000 live births, VSDs are the most common of all CHDs, accounting for 37% of all congenital heart disease.

A large VSD allows significant left-to-right shunting; pulmonary vascular resistance (PVR) is less than systemic vascular resistance (SVR), causing a left-to-right shunt. Highly oxygenated blood returning from the lungs is shunted across the defect and back to the lungs. This pulmonary overcirculation results in CHF, pulmonary edema, respiratory distress, and failure to thrive. A pansystolic murmur can be heard over the left sternal border.

3.

In an infant with congestive heart failure (CHF), medical management often includes digoxin (Lanoxin) therapy. A nurse should expect which of the following effects as a result of this medication?

Increased cardiac output

Increased renal perfusion

Increased heart rate

Increased blood pressure

Correct answer: Increased cardiac output

Medical management of CHF helps the heart to compensate with increased cardiac output. Maintaining the balance of pulmonary and systemic blood flow is the primary treatment approach to CHF in infants. Digoxin acts primarily as a positive inotropic agent, improving contractility and cardiac output and lowering the heart rate in infants with tachycardia.

Renal perfusion may improve as blood flow improves with increased cardiac output, but this is not the primary treatment goal.

4.

While caring for a preterm infant who is receiving indomethacin (Indocin) for the treatment of a persistent patent ductus arteriosus (PDA), a nurse should closely monitor which of the following parameters?

Urine output

Cardiac output

Blood pressure

Liver enzymes

Correct answer: Urine output

Severely symptomatic infants do require ductal closure by either pharmacologic management or surgical ductal ligation. Indomethacin, a prostaglandin synthesis inhibitor, is the first-line therapy for the treatment of persistent PDAs: it constricts and closes the PDA in some premature infants. Ibuprofen lysine is also effective. Indomethacin decreases blood flow to the renal system, thus reducing renal perfusion and urinary output (transient oliguria).

Urine output and creatinine levels must be closely monitored. If urine output decreases dramatically, the drug should be discontinued.

5.

When a nurse is assisting with neonatal endotracheal (ET) intubation, a portable bedside chest x-ray reveals the ET tube is inserted too far into the infant's chest. Where is the tube most likely located in this scenario?

Right mainstream bronchus

Left mainstream bronchus

Right upper lobe

Left upper lobe

Correct answer: Right mainstream bronchus

The right mainstream bronchus is at a 25-degree angle from the trachea versus the left mainstream bronchus (which is at a 45-degree angulation). This results in easier intubation of the right mainstream when the ET tube is inserted too far.

Auscultation of breath sounds in this scenario will reveal louder breath sounds on the right and no fogging or condensation in the ETT on exhalation.

6.

Which of the following 12-lead ECG findings is NOT indicative of a normal sinus rhythm in a healthy full-term 3-day-old neonate?

Narrow QRS complex with a fixed and regular R-R interval

Regular rhythm with a ventricular rate of approximately 120 beats/minute

P-wave with constant morphology preceding every QRS complex

Positive P-wave in leads I, II, and aVF

Correct answer: Narrow QRS complex with a fixed and regular R-R interval

A normal sinus rhythm (NSR) is defined as three consecutive beats with identical waveforms on an ECG. The waveform similarities indicate that the origin of the impulse is the same. NSR is defined by the following criteria:

- *a regular rhythm with a ventricular rate within an age-specific normal interval (during the first week post birth, the heart rate is approximately 120 beats/min)*
- *a P-wave with constant morphology preceding every QRS complex*
- *a P-wave that is positive in lead II (and also I and aVF)*

A fixed and regular R-R interval with narrow-complex QRS complexes and absent P-waves can often indicate supraventricular tachycardia (SVT). This infant will display persistent ventricular rates of over 200 to 220 beats/min and little variability in heart rate with various activities (e.g., crying, feeding, apnea).

7.

At birth, an infant takes their first few breaths, and the placenta is removed from the circulation. What happens to the newborn's systemic vascular resistance (SVR) at this time?

It increases significantly.

It decreases significantly.

It increases slightly.

It decreases slightly.

Correct answer: It increases significantly.

The labor process and an infant's first few breaths begin the termination of fetal circulation and the transition to newborn circulation. At birth, when the umbilical cord is occluded and the placenta is removed from circulation, the infant's SVR greatly increases. The first few breaths inflate the lungs for the first time and increase the oxygen content in the infant's blood. Both of these changes decrease pulmonary vascular resistance (PVR), leading to increased pulmonary blood flow.

8.

A neonate born prematurely via cesarean section at 28 weeks of gestation and weighing just over 1,000 g develops respiratory distress syndrome (RDS) soon after birth. The infant exhibits increasing respiratory difficulty related to progressive atelectasis in the first 6 hours after birth, leading to hypoxia and hypoventilation, and requires respiratory support and surfactant replacement therapy.

This infant's chest x-ray reveals hazy lung fields with fuzzy heart borders and a "whiteout" appearance. This indicates which of the following complications?

Acute pulmonary edema

Bronchopulmonary dysplasia (BPD)

Pneumonia

Atelectasis

Correct answer: Acute pulmonary edema

Chest x-ray findings in RDS include reduced lung volume, air bronchograms, reticulogranularity, and lung opacification.

Acute pulmonary edema is a complication of RDS and is evidenced by hazy lung fields with fuzzy heart borders on chest x-ray films. This loss of visible heart borders with a "whiteout" appearance is from the diffuse lung opacification in RDS.

9.

For infants born with hypoplastic left heart syndrome (HLHS), why is PGE1 with continuous infusion required?

To keep the ductus arteriosus patent

To manage acidosis aggressively

To increase pulmonary vascular resistance

To decompress the left atrium

Correct answer: To keep the ductus arteriosus patent

HLHS typically involves severe coarctation of the aorta, aortic valve stenosis or atresia, and mitral valve stenosis or atresia. The left ventricle and ascending aorta are hypoplastic, and blood flow to the body is dependent on right-to-left shunting through the PDA. Closure of the ductus arteriosus results in poor systemic perfusion and death. Therefore, pharmacologic maintenance of ductal patency with PGE1 with continuous infusion is required.

The goal is a balanced pulmonary and systemic circulation through the use of volume expansion, inotropic support, and intubation. Maneuvers such as hypoventilation to increase PVR and redirect cardiac output to the body have been used. Palliative cardiac surgeries are required for survival and occur over the first few years of life.

Other management options include systemic afterload-reducing agents, aggressive management of acidosis, and transcatheter balloon atrial septostomy to decompress the left atrium if the patient is not taken to surgery immediately after birth.

10.

Neonatal cardiogenic shock usually relates to congenital heart disease (with systemic to pulmonary shunting), myocarditis, and dysrhythmia. It involves three characteristics. Which of the following is NOT a characteristic of cardiogenic shock in neonates?

Decreased systemic vascular resistance (SVR)

Increased afterload

Decreased contractibility

Increased preload

Correct answer: Decreased systemic vascular resistance (SVR)

*Cardiac signs of shock include pulmonary hypertension (**increased** systemic vascular resistance), decreased cardiac output, and hypoxemia in the early phase, followed by an uncompensated decrease in cardiac output (CO), bradycardia, and hypotension. Increased preload, increased afterload, and decreased contractibility result in decreased CO and increased SVR to compensate for and protect vital organs.*

As CO continues to decrease, tissue perfusion and coronary artery perfusion decrease, fluid backs up, and the left ventricle fails to pump the blood adequately, resulting in pulmonary edema and right ventricular failure.

11.

A nurse is placing leads on an infant in preparation for a 12-lead ECG. Where is precordial lead V6 placed?

Horizontal to V5 at the left midaxillary line

Horizontal to V5 at the left anterior axillary line

Left midclavicular line at the fifth intercostal space (ICS)

Left sternal border at the fourth intercostal space (ICS)

Correct answer: Horizontal to V5 at the left midaxillary line

An ECG provides a graphic representation of the electrical activity of an infant's heart. It is indicated for cyanosis, cardiac arrhythmias, dyspnea, or other cardiovascular disorders and is used to determine the severity of disease by assessing the degree of atrial or ventricular hypertrophy. A standard 12-lead ECG gives a picture of electrical activity from 12 perspectives through the placement of 10 body leads:

- *Four limb leads are placed distally (on the wrists and ankles) but can be placed more proximally if necessary.*
- *Precordial leads are as follows:*
  - *V1: Right sternal border at the fourth ICS*
  - *V2: Left sternal border at the fourth ICS*
  - *V3: Midway between V2 and V4*
  - *V4: Left MCL at the fourth ICS*
  - *V5: Horizontal to V4 at the left anterior axillary line*
  - ***V6: Horizontal to V5 at the left midaxillary line***
- *In some cases, additional leads may be used:*
  - *Right-sided leads are placed on the right in a mirror-image of the left leads, usually to diagnose right-ventricular infarction through ST elevation.*
  - *Artifacts are **COMMON** in neonatal ECGs because of movement or incorrect lead placement.*

12.

A full-term infant has Apgar scores of 8 and 9 at one and five minutes, respectively. At approximately 12 hours after birth, the nurse auscultates a physiologic murmur. What should they do?

Closely monitor for any increase in intensity or quality

Notify the neonatologist of the finding

Order an electrocardiogram

Suspect a congenital heart defect

Correct answer: Closely monitor for any increase in intensity or quality

Heart murmurs are a common finding in neonates and can be normal (affecting up to 10% of the population). When the patent ductus arteriosus (PDA) closes, it causes a murmur; therefore, all newborns who go through the normal cardiac transition will have a transient murmur as the ductus arteriosus closes, generally within the first 48 hours following delivery. Although cardiac murmurs in the neonatal period do not necessarily indicate heart disease, they must be carefully monitored. The intensity (loudness), quality (harsh, vibratory), location, and radiation of the murmur can all help determine a diagnosis and should be closely monitored. Also, the absence of a murmur does not indicate the absence of significant cardiac disease.

Physician notification would not be necessary at this point, as this finding is integral to the normal transitional process. If the murmur worsens or persists, or the neonate develops symptoms, the physician should be notified. The presence of a congenital heart defect would likely be accompanied by other clinical signs and symptoms. A nurse should never order any diagnostic testing without approval by a physician.

13.

Which of the following statements about truncus arteriosus is TRUE?

A ventricular septal defect (VSD) is present in a majority of cases.

Cyanosis is always present at birth.

The pH and $PaCO_2$ are usually elevated.

The presence and severity of congestive heart failure (CHF) depends on the amount of systemic blood flow.

Correct answer: A ventricular septal defect (VSD) is present in a majority of cases.

Truncus arteriosus is characterized by one great (common) artery that stems from both the left and right ventricles, overriding a ventricular septal defect (VSD). A coexisting VSD is present in more than 98% of cases. This condition makes up 1% to 2% of all cardiac defects. These infants may present with cyanosis at birth, but this finding varies in intensity according to the amount of pulmonary blood flow.

The presence of CHF depends on the amount of pulmonary blood flow (not systemic blood flow); persistently high pulmonary arteriolar resistance in the first few weeks after birth limits excessive pulmonary blood flow, and CHF may not be evident until the PVR drops. The pH and $PaCO_2$ are usually normal (not elevated).

14.

An infant born with tetralogy of Fallot (TOF) is experiencing "tet" spells, which are hypercyanotic episodes consisting of severe and intractable cyanosis, irritability, pallor, tachypnea, and flaccidity. Medical management includes all the following interventions, EXCEPT:

Fluid restriction

Knee-chest positioning

Oxygen

Morphine

Correct answer: Fluid restriction

Infants with TOF are at risk for hypercyanotic (or "tet") spells. These spells may be secondary to a transient increase in the obstruction of the right ventricular outflow tract, resulting in minimal or no pulmonary blood flow. True "tet" spells rarely occur, but one significant spell should prompt early surgery because such spells can be life-threatening.

*The medical management of "tet" spells includes placing the infant in the knee-chest position. Oxygen, morphine, and **fluid boluses** can be needed. Calming the infant quickly is important. A beta-blocker (propranolol) and systemic vasopressor can also be tried.*

15.

When does the heart begin to beat in a human embryo?

22 to 23 days of life

42 to 43 days of life

18 to 19 days of life

12 to 14 days of life

Correct answer: 22 to 23 days of life

In human embryos, the heart begins to beat at about 22 to 23 days and begins to pump blood effectively in the fourth week of life.

The heart develops from the cardiogenic mesoderm and begins as a primitive heart tube. In the first few weeks of life, this "tube" receives blood from the cardinal, vitelline, and umbilical venous systems, supplying blood to six paired aortic arches. These veins and aortic arches each regress or progress, and the primitive heart tube must undergo a complex process of looping, shifting, and separating to result in a normal heart with normal atrial and venous communications. Cardiac development is nearly complete by week six of gestation, before pregnancy may even be recognized.

16.

Adenosine (Adenocard) is the MOST effective antidysrhythmic drug for the treatment of which of the following cardiac dysrhythmias?

Supraventricular tachycardia (SVT)

Sinus tachycardia

Atrial flutter

Premature ventricular contractions

Correct answer: Supraventricular tachycardia (SVT)

SVT is the most common tachydysrhythmia in the newborn period and can result from dual AV nodal pathways, rapid conduction through an accessory bundle, or the presence of an ectopic atrial pacemaker. It may be associated with specific heart disease as well. Various maneuvers can be used to attempt to convert the infant to a normal sinus rhythm; stimulation of the diving reflex by applying an ice pack to the neonate's face may be attempted and is the first line of treatment for a hemodynamically stable neonate with SVT.

Adenosine, a purinergic agonist, is an especially effective antidysrhythmic drug for the treatment of SVT; it works by slowing the sinus rate and producing transient AV block, which can interrupt some types of SVT.

17.

What is the function of the ductus arteriosus in a fetus?

To provide an opening to shunt blood from the pulmonary artery to the aorta

To shunt blood from the inferior vena cava to the pulmonary artery

To allow for lower pulmonary pressures

To allow for the exchange of oxygen and carbon dioxide

Correct answer: To provide an opening to shunt blood from the pulmonary artery to the aorta

Fetal lungs are not used for breathing. The work of exchanging oxygen and carbon dioxide is done by the placenta. Because of high pulmonary vascular resistance (PVR), fetal circulation shunts most of the blood away from the lungs.

Blood is shunted from the pulmonary artery to the aorta through the ductus arteriosus, a connecting fetal blood vessel. Blood traveling through the ductus arteriosus has a lower oxygen content and supplies the lower portion of the fetal body before returning to the placenta through the two umbilical arteries. Blood then enters the placental circulation and is resaturated.

18.

Which of the following types of heart murmurs is commonly heard in infants with truncus arteriosus?

A pansystolic murmur

A holosystolic murmur

A diastolic murmur

A continuous murmur

Correct answer: A pansystolic murmur

Truncus arteriosus is characterized by one great artery arising from the left and right ventricles, overriding a VSD. This single artery has one valve and gives rise to the coronary, pulmonary, and brachiocephalic arteries. A second semilunar valve is absent. A coexisting VSD is present in more than 98% of cases.

S1 (the first heart sound) is normal, but S2 is single and loud because of the single valve of the common trunk. A loud systolic ejection click is frequently heard, and a ***loud pansystolic murmur*** *that radiates to the entire precordium is heard maximally at the lower left sternal border. If the single truncal valve is insufficient, a blowing diastolic murmur may be heard. Wide pulse pressure is often present.*

19.

When performing compressions on a newborn, where should the nurse apply pressure?

At the lower third of the sternum

On the upper third of the sternum

Directly over the xiphoid process

At any of these sites

Correct answer: At the lower third of the sternum

*Chest compressions on a newborn should apply pressure to the **lower one third of the sternum**, typically in line with the nipples. Do this by encircling the neonate's chest with your hands and providing support for the back with your fingers. Thumbs should remain in constant contact with the chest yet allow the chest to rise fully during the release phase.*

Pressure should be applied in a downward fashion, perpendicular to the chest wall to depress the sternum about one third of the anterior-posterior diameter of the chest, followed by release of pressure to allow for refilling of the heart. Avoid placing direct pressure on the xiphoid and the ribs (which can result in liver injury).

20.

What is the MOST common cardiac cause of death in the first week of life?

Hypoplastic left heart syndrome (HLHS)

Tetralogy of Fallot (TOF)

Total anomalous pulmonary venous return (TAPVR)

D-transposition of the great arteries

Correct answer: Hypoplastic left heart syndrome (HLHS)

HLHS represents a clinical spectrum that includes severe coarctation of the aorta, severe aortic valve stenosis or atresia, and severe mitral valve stenosis or atresia; it accounts for 1% to 4% of all cardiac defects and is responsible for 23% of cardiac-related deaths in the first week of life. Congestive heart failure is usually the main problem as a result of right ventricular volume and pressure overload.

Currently, up to 65% to 70% of infants are expected to survive all three palliative surgical procedures, but longer-term survival is not easily achieved.

21.

In fetal circulation, blood from which of the following structures enters the inferior vena cava?

Ductus venosus

Right atrium

Mitral valve

Superior vena cava

Correct answer: Ductus venosus

Fetal circulation relies on the placenta for gas exchange, whereas postnatal circulation uses the lungs for gas exchange. Highly oxygenated blood from the mother enters the fetal circulation through the umbilical cord vein. This blood enters the inferior vena cava via the ductus venosus. Blood from the inferior vena cava enters the right atrium. Most of this blood is directed through the foramen ovale and into the left atrium LA. Blood then passes through the mitral valve into the left ventricle and through the aortic valve into the aorta.

22.

The parents of an infant born with congenital heart disease (CHD) inquire why the heart defect was not detected on a fetal echocardiogram. What is the BEST response?

"A fetal echocardiogram detects under 50% of severe CHD cases."

"It would be best to ask the neonatologist."

"The fetal heart is not fully examined during a fetal echocardiogram."

"About 15% of infants with an abnormal fetal echocardiogram are diagnosed with CHD after birth."

Correct answer: A fetal echocardiogram detects under 50% of severe CHD cases.

Fetal echocardiograms are routinely done on mothers with a history that suggests CHD. A family history of CHD, fetal malformations on routine prenatal ultrasounds, abnormal fetal heart rhythm, maternal insulin-dependent diabetes, or exposure to unknown teratogens are also possible indications for a fetal echocardiogram.

The recommended timing for a fetal echocardiogram is between 18 and 20 weeks of gestation, although a detailed cardiac evaluation and an accurate CHD diagnosis can be made as early as 12 weeks of gestation. Unfortunately, under half of children with severe CHD receive a prenatal diagnosis (30% to 50% of severe CHD is detected before birth).

23.

For neonates, in which of the following congenital heart defects is cyanosis ALWAYS present to varying degrees?

Tricuspid atresia

Coarctation of the aorta

Atrioventricular (AV) septal defect

Pulmonary stenosis

Correct answer: Tricuspid atresia

*In tricuspid atresia, there is complete agenesis of the tricuspid valve with **no direct communication** between the right atrium and right ventricle (i.e., no blood can flow from the right atrium to the right ventricle). Tricuspid atresia will **always produce cyanosis** in neonates, although the degree of cyanosis varies. Newborns will have marked cyanosis if the pulmonary blood flow is compromised. Oxygen saturations should be greater than 75% due to the complete mixing of oxygenated and deoxygenated blood within the heart.*

Coarctation of the aorta generally does not produce cyanosis in newborns with isolated events, but an oxygen saturation difference may be found between the upper and lower extremities. Unless another heart defect is present, goal saturations should be greater than 92%.

AV septal defects may or may not present with mild cyanosis, particularly in the immediate neonatal period before the pulmonary vascular resistance has fallen. Goal saturations should be greater than 75% on room air.

Cyanosis is generally not present in pulmonary stenosis but may occur in the presence of a right-to-left atrial shunt, and goal saturations are often greater than 85% due to decreased pulmonary blood flow.

24.

The nurse is caring for an infant who just underwent surgical repair of a ventricular septal defect (VSD). The nursing plan of care should include monitoring closely for which of the following complications?

Persistent shunt

Pulmonary hypertension

Right ventricular failure

Pulmonary hypotension

Correct answer: Persistent shunt

Surgical treatment of a VSD consists of either suture closure or patching using synthetic material such as Dacron. Complications or residual effects can include a persistent shunt (residual VSD), conduction abnormalities such as a right bundle-branch block and third-degree heart block, and—less commonly—aortic or tricuspid insufficiency (under 1%). Other common surgical complications include bleeding and infection.

Pulmonary hypotension or hypertension and right ventricular failure are not common complications of a VSD repair.

25.

What is the MOST common cyanotic congenital heart defect?

Tetralogy of Fallot (TOF)

Pulmonary stenosis

Coarctation of the aorta

Atrioventricular septal defect

Correct answer: Tetralogy of Fallot (TOF)

TOF is the most common cyanotic heart lesion, accounting for 10% of all defects and occurring in 1 per 5,000 live births. The components of TOF are VSD, an overriding of the ascending aorta, an obstruction of the right ventricular outflow tract (pulmonary stenosis), and right ventricular hypertrophy. The predominant intracardiac shunt is usually right to left; therefore, most infants with TOF are cyanotic to varying degrees, depending on the amount of right-to-left intracardiac shunting and the amount of blood that enters the pulmonary circulation through the right ventricle.

Pulmonary stenosis is a narrowed opening either in the pulmonary valve due to pulmonary valve cusp fusions or above or below the valve because of tissue hypertrophy. The incidence is 1 in 14,000 live births and comprises 5% to 8% of all CHDs.

Coarctation of the aorta is a localized constriction that usually occurs at the junction of the transverse aortic arch and the descending aorta, near the ductus arteriousus. It is one of the more common CHDs, accounting for approximately 7% of cardiac lesions.

Atrioventricular septal defects occur when the endocardial cushions that form the central crux of the heart do not form normally; this can result in mild cyanosis, particularly in the immediate neonatal period. Nearly 70% of infants with this condition had trisomy 21 (Down's syndrome) in a single-site review conducted over 10 years.

26.

An infant born at 34 weeks of gestation is now 21 days old and healthy enough for hospital discharge. The nurse needs to perform a car seat tolerance screening (CSTS) before discharge to ensure safe transportation.

When applying the cardiac leads for cardiorespiratory monitoring, where should the nurse place the WHITE lead?

Under the right clavicle, at the mid-clavicular line within the rib cage frame

Under the left clavicle, at the mid-clavicular line within the rib cage frame

At the left lower abdomen within the rib cage frame

At the right lower left abdomen within the rib cage frame

Correct answer: Under right clavicle, mid-clavicular line within the rib cage frame

In car seats, preterm infants may experience oxygen denaturation, apnea, and bradycardia caused by head slouching and airway obstruction. For these reasons, a CSTS before discharge is recommended for all infants born before 37 weeks of gestation; this includes late-preterm infants (i.e., 34 to $36^{6/7}$ weeks) who are cared for at and discharged from level I/normal newborn nurseries.

The car seat must be purchased by the parents, and the infant must be positioned in the seat immediately before discharge while on cardiorespiratory and pulse oximetry monitoring (for 30 to 90 minutes depending on hospital protocols). Respiratory/heart rates, oxygen saturations, and apnea/bradycardia events must be recorded.

***The RA (white) electrode is placed under the infant's right clavicle at the mid-clavicular line within the rib cage frame**. Place the LA (black) electrode under the left clavicle, at the mid-clavicular line within the rib cage frame, and place the LL (red) electrode on the lower left abdomen within the rib cage frame.*

27.

Tetrology of Fallot (TOF) is a congenital heart condition often requiring surgical intervention in the first year of life to correct the structural defects. Which of the following is present with TOF?

Right ventricular hypertrophy

Coarctation of the aorta

Transposition of the great arteries

Patent ductus arteriosis

Correct answer: Right ventricular hypertrophy

TOF is the most common cyanotic congenital heart disease. The four components of TOF are:

- *an overriding of the ascending aorta*
- *ventricular septal defect (VSD)*
- *obstruction of the right ventricular outflow tract*
- *hypertrophy of the right ventricle*

Total surgical repair of TOF is not usually carried out in the neonatal period. Surgery (intracardiac repair) is usually performed electively within the first year of life via closure of the VSD with a patch and eliminating the pulmonary stenosis by resection; in addition, the pulmonary outflow tract may be enlarged by a patch. If surgical intervention in infancy is warranted due to severe hypoxia, a systemic-to-pulmonary shunt (Blalock-Taussig shunt) is performed to provide adequate pulmonary blood flow until a complete surgical repair is done at a later date.

28.

On analysis of a 12-lead ECG for the mechanism of dysrhythmia in a neonate, a notation should be made in three main areas.

Which of the following is NOT one of these areas?

ST segment

Atrial and ventricular rates

Rhythm

QRS morphology

Correct answer: ST segment

When evaluating an infant with dysrhythmia, it is essential to assess simultaneously their electrophysiology and hemodynamic status. A neonate with poor perfusion and hypotension should first be treated for shock.

*A 12-lead ECG can be done for a definitive diagnosis of the type of dysrhythmia. The **three main areas** that should be notated are atrial and ventricular rates, rhythm, and QRS morphology.*

The ST segment is the part of the ECG between the end of the S wave and the start of the T wave. In a healthy infant, there should be an isoelectric line (neither elevated nor depressed). Abnormalities of the ST segment should be investigated to rule out pathology, but this is not one of the three main areas of notation.

29.

What is one of the biggest risk factors in a newborn with a cyanotic congenital heart defect?

Polycythemia

Tetrology of Fallot (TOF)

Renal damage

Heart murmur

Correct answer: Polycythemia

Cyanosis is one of the most common presenting signs of congenital heart disease in neonates, occurring when deoxygenated venous blood abnormally shunts "right to left" within the heart and then enters the systemic arterial system again (bypassing the lungs to pick up oxygen). This results in chronic hypoxemia. In response to hypoxemia, the kidneys produce erythropoietin to enhance the production of red blood cells. The increased number of red blood cells results in polycythemia.

TOF is the most common cause of cyanotic congenital heart disease. Heart murmurs and renal damage are not as significant of risk factors as polycythemia.

30.

Cyanosis—a bluish discoloration of the skin, nail beds, and mucous membranes—can occur when deoxygenated hemoglobin is present in the circulating blood. Above what threshold is clinically apparent cyanosis usually visible?

3-5 g/dL of desaturated hemoglobin in the arterial system

13-16 g/dL of desaturated hemoglobin in the arterial system

30-40 g/dL of desaturated hemoglobin in the arterial system

300 g/dL of desaturated hemoglobin in the arterial system

Correct answer: 3-5 g/dL of desaturated hemoglobin in the arterial system

Cyanosis is one of the most common presenting signs of congenital heart disease (CHD) in newborns and occurs with CHD when deoxygenated venous blood abnormally shunts right-to-left within the heart and enters the systemic arterial system again (without going through the lungs to pick up oxygen).

Depending on the underlying skin complexion, clinically apparent cyanosis is usually not visible until there is more than 3 to 5 g of desaturated hemoglobin per deciliter in the arterial system. Cyanosis depends on both the severity of hypoxemia and the hemoglobin concentration.

IB. Respiratory

31.

Meconium aspiration syndrome (MAS) is associated with which of the following pathophysiologic mechanisms?

Uneven aeration, risk of air trapping and impaired gas exchange, and inactivation of surfactant

Lungs prone to atelectasis becoming susceptible to volutrauma

Hemodynamic impairment and restricted chest and diaphragmatic movement

Gas interstitium compressing the alveoli, airways, and pulmonary venules

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Correct answer: Uneven aeration, risk of air trapping and impaired gas exchange, and inactivation of surfactant

With MAS, a hypoxic event in utero stimulates intestinal peristalsis and relaxation of the anal sphincter, resulting in the expelling of meconium into the amniotic fluid. Respirations after birth draw meconium into the major and then smaller airways, causing uneven aeration, obstruction, atelectasis, air trapping, and pneumothorax. Meconium can also cause the inactivation of surfactant, further impairing gas exchange and potentiating barotrauma and promoting an inflammatory response known as chemical pneumonitis.

Respiratory distress syndrome (RDS) is characterized by atelectasis-prone lungs susceptible to volutrauma. Hemodynamic impairment and restricted chest and diaphragmatic movement may occur with severe NEC or impaired gastroschisis. Pneumothorax and pulmonary interstitial emphysema result from gas interstitium compressing the alveoli, airways, and pulmonary venules.

32.

Positive end-expiratory pressure (PEEP) may cause an increase in which of the following?

Pulmonary vascular resistance (PVR)

Systemic vascular resistance (SVR)

Mean airway pressure (MAP)

Pulmonary artery occlusion pressure (PAOP)

Correct answer: Pulmonary vascular resistance (PVR)

*Effects of changes in PEEP depend on the severity of lung disease and degree of lung inflation. High PEEP in the presence of relatively compliant lungs will cause overdistention, worsening PaO2, and an **increase in PVR**. In addition, overdistention may increase the risk of barotrauma.*

However, levels of PEEP that are too low contribute to hypoxia and pulmonary hypertension because of low lung volumes. Acute lung injury is worsened by the failure to recruit adequate lung volume by using insufficient PEEP.

33.

What is the definition of central apnea in neonates?

Absence of breathing effort and airflow

Presence of breathing effort and absence of airflow

Pauses in breathing for up to 10 seconds followed by a series of rapid, shallow breaths and then normal breathing returns without intervention

A condition with neurologic and obstructive components

Correct answer: Absence of respiratory effort and airflow

Causes of apnea in premature infants consist of:

- *central apnea, in which there is an absence of breathing effort (without respiratory effort, airflow is zero)*
- *obstructive apnea, in which breathing efforts occur but the airway is blocked*
- *mixed apnea, in which an initial central apnea occurs followed by obstruction of the airway*

Periodic breathing is defined as pauses in breathing followed by a series of rapid, shallow breaths and then resuming normal breathing without intervention. This periodic breathing may be observed in infants during non-REM sleep.

34.

What is the desired therapeutic level of caffeine citrate for a neonate with diagnosed apnea of prematurity?

5-25 mcg/mL

26-40 mcg/mL

1-4 mcg/mL

10-15 mcg/mL

Correct answer: 5-25 mcg/mL

Apnea of prematurity is treated with methylxanthines (e.g., caffeine, theophylline, aminophylline), which are potent cardiac, respiratory, and CNS stimulants and smooth muscle relaxers. Caffeine citrate is considered the drug of choice for apnea of prematurity because (1) administration is once a day; (2) there is an earlier onset of action; (3) it has a wide therapeutic range, requiring fewer serum blood level evaluations; (4) there is no alteration of CBF; and (5) there are fewer side effects than with theophylline.

The therapeutic level for management of apnea of prematurity is 5 to 25 mcg/mL. Toxic levels are above 40-50 mcg/mL.

35.

Analyze the following arterial blood gases of a term infant whose delivery was complicated by meconium aspiration:

- pH: 7.36
- CO2: 63
- HCO3: 28

Which, if any, acid-base disorder do these values represent?

Compensated respiratory acidosis

Uncompensated respiratory alkalosis

Compensated metabolic acidosis

Uncompensated metabolic alkalosis

Correct answer: Compensated respiratory acidosis

This arterial blood gas result indicates compensated respiratory acidosis. The pH is between 7.35 and 7.45, so the value is compensated. Because it is closer to 7.35, the value is considered acidotic.

To determine whether acidosis is respiratory or metabolic, find the value that represents acidosis. In this scenario, it would be CO2 at 63 mm Hg (normal values are 35 to 45). The most common pulmonary cause of respiratory acidosis in term newborns is obstructive lung disease, such as meconium aspiration and transient tachypnea of the newborn (TTN).

36.

Analyze the following arterial blood gas values of an infant born at 32 weeks on 2L oxygen via nasal cannula:

- pH: 7.56
- CO2: 33
- HCO3: 25

Which, if any, acid-base disorder do these values represent?

Uncompensated respiratory alkalosis

Normal values

Compensated respiratory acidosis

Uncompensated (mixed) respiratory/metabolic alkalosis

Correct answer: Uncompensated respiratory alkalosis

This result is uncompensated respiratory alkalosis because the pH is greater than 7.45 (normal is 7.35 to 7.45), so the value is uncompensated alkalosis.

To determine whether the alkalosis is respiratory or metabolic, find the value that represents alkalosis. This would be CO2 at 34 mm Hg (normal is 35 to 45). HCO3 is within the normal range in this scenario (22 to 26 mmol/L).

37.

Surfactant production is accelerated in all of the following scenarios, EXCEPT:

Acidemia and hypoxemia

Premature rupture of membranes for over 48 hours

Infants subjected to maternal infection

Infants of heroin-addicted mothers

Correct answer: Acidemia and hypoxemia

Surfactant provides multiple useful properties in addition to reducing surface tension, thus increasing lung compliance, providing alveolar stability, and decreasing opening pressure. In addition, surfactant enhances alveolar fluid clearance, decreases precapillary tone, and helps protect the epithelial cell surface. Surfactant is constantly being formed, stored, secreted, and recycled.

Surfactant production is accelerated in the following:

- *infants of diabetic mothers (IDMs) of classes D, F, and R*
- *infants of heroin-addicted mothers*
- *premature rupture of membranes of greater than 48 hours' duration*
- *infants of mothers with hypertension*
- *infants subjected to maternal infection*
- *infants suffering from placental insufficiency*
- *infants affected by administration of corticosteroids*
- *infants affected by abruption placentae*

Conditions that interfere with surfactant metabolism include:

- ***acidemia***
- ***hypoxemia***
- *shock*
- *overinflation or underinflation*
- *pulmonary edema*
- *mechanical ventilation*
- *hypercapnia*

Surfactant production is delayed in infants with the following conditions:

- *IDMs classes A, B, and C*
- *erythroblastosis fetalis*

- *infants who are the smaller of twins*

38.

A neonate born at 29 weeks is receiving treatment via oxygen hood with a 50% FiO_2. The neonatologist suspects the patient has worsening respiratory distress syndrome (RDS). The following blood gas results were obtained:

- $PaCO_2$ = 38 mm Hg
- pH = 7.36
- HCO_3 = 25 mEq/L
- PaO_2 = 46
- Base excess = 0

Based on these results, which of the following interventions is recommended?

Initiate a trial of nasal CPAP at 5-8 cm H_2O

Increase oxygen hood concentration to 100%

Intubate and initiate mechanical ventilation with PEEP

Obtain a chest x-ray for evidence of air leaks (pneumothorax)

Correct answer: Initiate a trial of nasal CPAP at 5-8 cm H_2O

The pH of 7.36 (7.35-7.45) and $PaCO_2$ of 38 mm Hg (35 to 45 mm Hg) are both within normal ranges. Therefore, in this scenario, an initial trial of nasal CPAP (nCPAP) should be attempted before intubation and mechanical ventilation due to its much less invasive nature. The goal is to try to avoid mechanical intubation if at all possible.

If the infant does not improve, mechanical ventilation will be necessary.

39.

Tachypnea is the earliest sign of respiratory disease in a neonate. It is defined by which of the following rates?

60 breaths/min or greater after the first hour from birth

70 breaths/min or greater after the first hour from birth

50 breaths/min or greater after the first hour from birth

80 breaths/min or greater after the first hour from birth

Correct answer: 60 breaths/min or greater after the first hour from birth

A normal respiratory rate in a neonate is 30 to 60 breaths/minute. Tachypnea is a rate of 60 breaths/min or greater after the first hour post-birth and is the earliest sign of respiratory disease.

As a compensatory mechanism, tachypnea attempts to maintain alveolar ventilation and gaseous exchange. However, it increases oxygen demand, energy output, and the "work" of breathing.

40.

Which of the following congenital chest masses generally presents in infants as hyperinflation of one or more lung lobes?

Congenital lobar emphysema

Congenital pulmonary airway malformations (CPAMs)

Pulmonary sequestrations

Bronchogenic cysts

Correct answer: Congenital lobar emphysema

Congenital lobar emphysema typically manifests in neonates as hyperinflation of one or more lung lobes. This condition is not generally discovered in utero.

Hyperinflation of a pulmonary lobe develops after birth because inspired air enters the affected lobe but cannot exit; this is because the positive pressure of expiration collapses the malacic airway.

Congenital lobar emphysema most commonly affects the upper lobes. Infants may present with mild or moderate respiratory distress, and a mediastinal shift may develop with progressive trapped air. Decreased breath sounds are auscultated on the involved side. Causes of this condition include bronchomalacia of cartilaginous rings or external compression of a segmental bronchus by a large pulmonary artery that predisposes to air trapping. Treatment involves surgical resection of the mass.

41.

In most cases of respiratory distress syndrome (RDS), which of the following factors is present?

Prematurity

Pulmonary hyperperfusion

Increased lung compliance

Persistent pulmonary hypertension of the newborn

Correct answer: Prematurity

*Infants born with immature lungs are at risk of respiratory distress. **Prematurity** is the most common factor in the occurrence of RDS. Its incidence is inversely proportional to gestational age and occurs most frequently in infants weighing below 1200 g and born before 30 weeks of gestation. RDS affects male infants twice as frequently as female infants, with the primary cause being a deficiency in surfactant.*

Pulmonary hypoperfusion and low lung compliance (i.e., little change in volume is achieved with a relatively great application of pressure, thereby contributing to increased work of breathing), are present in infants with RDS. Pulmonary hypertension complicates approximately 25% of these cases (not a majority).

42.

A preterm infant is receiving caffeine for apnea. The nurse notes a heart rate of 195 beats/minute just prior to administering the morning dose of medication. The infant is resting quietly in the incubator.

What should the nurse do?

Withhold the dose and notify the physician

Wait 20-30 minutes before administering the dose

Administer the dose

Recheck the infant's heart rate and administer the dose if it is below 180 beats/minute

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Correct answer: Withhold the dose and notify the physician

Caffeine citrate is considered the drug of choice for apnea of prematurity. However, tachycardia is a side effect of this medication. The dose should be withheld if the infant's heart rate is >180 beats/minute, and the physician should be notified immediately of the finding. The infant should have a serum blood level drawn and evaluated for caffeine toxicity.

The nurse should monitor the infant closely for other signs of adverse effects of the medication, including dysrhythmias, diuresis, jitteriness, seizure activity, and vomiting.

43.

Type I pneumocytes within the lungs are responsible for which process?

Providing gas exchange in the alveoli

Producing surfactant

Producing macrocytes

Producing phagocytes

Correct answer: Gas exchange in the alveoli

In the healing and repair process, type II alveolar cells (which are responsible for producing surfactant) multiply and differentiate into type I pneumocytes, which provide alveolar epithelium and are responsible for the gas (oxygen and carbon dioxide) exchange that takes place in the alveoli.

Type I pneumocytes cannot replicate when an insult occurs; therefore, type II pneumocytes will replicate to replace damaged type 1 pneumocytes.

44.

Which of the following statements about meconium aspiration syndrome (MAS) in neonates is ACCURATE?

Meconium promotes an inflammatory response known as chemical pneumonitis.

Meconium aspiration will always require mechanical ventilation.

Only term or post-term infants are affected by MAS.

Routine intrapartum tracheal suctioning will prevent MAS.

Correct answer: Meconium promotes an inflammatory response known as chemical pneumonitis.

For meconium to enter the amniotic fluid, a hypoxic event must occur in utero, stimulating fetal intestinal peristalsis and relaxation of the anal sphincter. This results in the expelling of meconium into the amniotic fluid and, in severe cases, gasping in utero that leads to meconium aspiration. This condition occurs more frequently in term or post-term infants following a hypoxic event in utero, although it can affect infants of any gestational age. Respirations after birth draw meconium into the airway, causing obstruction, atelectasis, air trapping, and pneumothorax. Meconium can also cause chemical pneumonitis and the inactivation of surfactant, further impairing gas exchange. MAS is a common reason for lung disease in newborns.

Mechanical ventilation is not always warranted; some infants respond to suctioning and CPAP alone, but others require full ventilator support. Recent studies have shown no significant difference in the incidence of MAS with routine intrapartum tracheal suctioning vs. no suctioning. Routine tracheal suctioning is no longer recommended for nonvigorous or depressed infants (e.g., nonvigorous infants with depressed tone and respirations and/or a heart rate below 100 beats/min). While this condition occurs more often in term or post-term infants when a hypoxic episode is experienced in utero, it affects approximately 8% to 29% of all newborns delivered.

45.

A neonate born prematurely via cesarean section at 28 weeks of gestation and weighing just over 1,000 g develops respiratory distress syndrome (RDS) soon after birth. The infant exhibits increasing respiratory difficulty related to progressive atelectasis in the first 6 hours after birth, leading to hypoxia and hypoventilation, and requires respiratory support and surfactant replacement therapy.

In this scenario, what is generally the FIRST sign of respiratory distress?

Tachypnea

Cyanosis

Subcostal retractions

Audible expiratory grunting

Correct answer: Tachypnea

*Tachypnea (>60 breaths per minute) is usually the **first** sign of respiratory distress. The patient's color is initially maintained; as the disease progresses, cyanosis will become evident due to increasing hypoxemia. Audible expiratory grunting follows during the first several hours after birth. It is caused by the forcing of air past a partially closed glottis and is used by the infant to maintain positive end-expiratory pressure (PEEP) at the alveolar level in an attempt to prevent alveolar collapse. It is more pronounced in patients with severe disease.*

The infant's chest wall is highly compliant and with RDS, it produces greater negative pressure by caving inward with a moderate decrease in pleural pressure. This results in retractions. Retractions are seen at the sternum and subcostal and intercostal spaces of the infant's chest. Nasal flaring is also present, and paradoxical seesaw respirations can occur.

46.

Pulmonary interstitial emphysema (PIE) results when free air is released from which structure?

Ruptured alveoli

Pleural space

Subcutaneous tissue

Connective tissue

Correct answer: Ruptured alveoli

PIE is generally a complication of mechanical ventilation and occurs when free air is released from ruptured alveoli. This free air intravasates into interstitial tissue and can compromise pulmonary vascular circulation and ventilation. Localized PIE sometimes resolves spontaneously but can frequently continue for weeks or even months.

Subcutaneous emphysema is a collection of extraneous air in the subcutaneous tissue. Extraneous air in the pleural space is indicative of a pneumothorax.

47.

Advantages of bubble CPAP include which of the following?

The system is cost-effective, readily available, and simple.

The gas does not need to be heated.

Bubble CPAP uses the same pressure sources as ventilatory CPAP.

The system delivers continuous positive airway pressure at two separate CPAP levels.

Correct answer: The system is cost-effective, readily available, and simple.

As long as heaters and a gas source are available, the bubble CPAP is cost-effective, readily available, and simple to use. The system utilizes a bottle of sterile water and CPAP tubing. The level of water in which the expiratory end of the CPAP tubing is submerged determines the amount of pressure generated. As with other methods of CPAP delivery, the gas must be heated. CPAP delivers pressure continuously through both phases of breathing. Special devices offer bilevel positive airway pressure.

In ventilatory CPAP, a variable resistance in a valve is adjusted to provide resistance to the flow of air. In bubble CPAP, the positive pressure in the circuit is achieved by simply immersing the distal expiratory tubing in a water column to the desired depth rather than using a variable resistor.

48.

A nurse is caring for an infant born at 30 weeks of gestation who is in acute respiratory failure. The infant is receiving oxygen therapy and has arterial blood gases (ABGs) scheduled every six hours. This infant's arterial oxygen tension should remain in which range?

60 to 80 mm Hg

35 to 45 mm Hg

70 to 90 mm Hg

45 to 65 mm Hg

Correct answer: 60 to 80 mm Hg

In a preterm infant, optimal arterial blood gases should be maintained between:

- *PaO2: 60 to 80 mm Hg*
- *PaCO2: 35 and 45 mm Hg*
- *pH: 7.35 and 7.45*

49.

Which of the following conditions may result in difficulty weaning an infant from mechanical ventilation?

Patent ductus arteriosis (PDA)

Respiratory distress syndrome (RDS)

Transient tachypnea of the newborn (TTN)

Meconium aspiration syndrome (MAS)

Correct answer: Patent ductus arteriosis (PDA)

A left-to-right shunt via the PDA results in blood flow from the aorta into the pulmonary artery, thus increasing pulmonary blood flow. The increased pulmonary artery pressure and increased left ventricular pressure and volume lead to pulmonary edema and bilateral congestive heart failure (limiting the physiologic ability to wean successfully from the ventilator).

The PDA will often present clinically in 4 to 7 days after birth with an inability to wean from the ventilator or a need for increased ventilatory and oxygen support.

50.

A hyperoxia test is ordered for a newborn who presents with tachypnea and mild cyanosis. An arterial blood gas (ABG) is drawn from the right radial artery with the infant breathing room air, then again after the infant has been on 100% oxygen for five minutes. Their PaO2 is 180 mm Hg.

This result indicates which of the following?

Respiratory distress syndrome

Cyanotic heart disease

Persistent pulmonary hypertension (PPHN)

Congenital heart disease (CHD)

Correct answer: Respiratory distress syndrome

A hyperoxia test is beneficial in differentiating respiratory disease from cyanotic heart disease. This test is a sensitive and specific tool in the initial evaluation of a neonate with suspected CHD and is used to investigate the possibility of a fixed right-to-left shunt. A right-to-left shunt is demonstrated if a patient's PO_2 does not increase in 100% oxygen.

Blood gas measurements are obtained (preferably from the right radial artery) when the infant is breathing room air and then after the infant has been in 100% oxygen for 5 to 10 minutes. A significant increase in PaO2 levels, ***particularly a PaO2 of >150 mm Hg****, makes respiratory distress more likely rather than cardiac in origin (the presence of a right-to-left shunt and CHD as the cause of cyanosis is unlikely).*

Levels below 50 to 60 mm Hg may be related to the transposition of the great vessels or from defects in pulmonary outflow. Infants with PPHN commonly present with hypoxia and hypoxemia.

51.

The respiratory rate in high-frequency ventilation (HFV) is determined by the Hertz setting. What does one Hertz represent?

60 breaths per minute

30 breaths per minute

90 breaths per minute

100 breaths per minute

Correct answer: 60 breaths per minute

One Hertz represents 60 breaths per minute. Therefore, 10 Hertz equals 600 breaths/minute. The rate is initially set between 10 and 15 Hz. Hertz indicates the rate at which fresh gases are delivered to the lungs.

52.

A male infant was born at 28 weeks of gestation via cesarean section. Immediately following delivery, the infant developed respiratory distress and required supplemental oxygen therapy and mechanical ventilation. His chest x-ray shows a reduction in lung volume and expansion with diffuse atelectasis.

What is the MOST likely cause of his respiratory distress?

Surfactant deficiency

Transient tachypnea of the newborn

Pulmonary hypertension

Bronchopulmonary dysplasia

Correct answer: Surfactant deficiency

Chest x-ray findings in an infant with surfactant-deficient respiratory distress syndrome include diffuse atelectasis, a reduction in lung volume, and decreased lung expansion.

Atelectasis increases lung density and results in visible outlines of air-filled bronchi against opaque lung tissue. Chest x-ray results also have a ground-glass appearance that represents areas of atelectatic respiratory alveoli adjacent to expanded or hyperexpanded respiratory units.

53.

Infants requiring prolonged hospitalization in the NICU are at risk of developing pneumonia due to which of the following?

Nosocomially acquired organisms

Proximity to other ill infants

Frequent handling by various healthcare professionals and family members

Prolonged ventilator use

Correct answer: Nosocomially acquired organisms

Neonates requiring prolonged hospitalization in the NICU can develop pneumonia from nosocomially acquired organisms. The causative organisms are mainly group B streptococci and gram-negative organisms (e.g., E. coli, Klebsiella, Pseudomonas) but also include Staphylococcus aureus, Streptococcus pneumoniae, and Candida.

Although the other choices do put infants at risk of acquiring pneumonia, nosocomially acquired organisms are the greatest risk factor for infants with prolonged NICU stays.

54.

A nurse is caring for a preterm infant with respiratory distress syndrome who is receiving bubble continuous positive airway pressure (CPAP). All the following are recommended nursing interventions EXCEPT:

Continuous monitoring of alarms indicating a leak in the system

Frequent emptying of the exhalation tube

Continuous monitoring of pressure at the nasal airway interface

Using an adjustable pressure-relief valve in the circuit

Correct answer: Continuous monitoring of alarms indicating a leak in the system

Bubble CPAP is a non-invasive ventilation strategy for newborns with respiratory distress syndrome (RDS). It is one of the methods by which CPAP is delivered to a spontaneously breathing newborn to maintain lung volumes during expiration. Condensation in the exhalation limb of a patient circuit during bubble CPAP accumulates at a rate of 3.8 mL/hr. When this condensation reaches volumes above 10 mL, the oscillating fluid increases airway pressure and results in increases in mean tracheal pressure. Frequent emptying (every 2-3 hours) of the exhalation tube, continuous monitoring of pressure at the nasal airway surface, and using an adjustable pressure-relief valve in the circuit (set to 5 cm H2O pressure above the desired mean pressure) are all recommended interventions when caring for an infant receiving bubble CPAP therapy.

The bubble system has no audible alarms to indicate a leak in the system; instead, the nurse would notice a cessation of bubbling in the underwater chamber.

55.

Which of the following statements is TRUE regarding premature infants?

A premature infant has a more compliant chest cage and less compliant lungs, resulting in a greater respiratory workload.

A premature infant has a less compliant chest cage and less compliant lungs, resulting in a greater respiratory workload.

A premature infant has a less compliant chest cage and more compliant lungs, resulting in a greater respiratory workload.

A premature infant has a more compliant chest cage and more compliant lungs, resulting in a greater respiratory workload.

Correct answer: A premature infant has a more compliant chest cage and less compliant lungs, resulting in greater respiratory workload.

Because a premature infant has a more compliant chest cage and less compliant lungs, a greater respiratory workload ensues. Respiratory muscle fatigue occurs easily in the absence of fatigue-resistant fibers.

56.

Which of the following sets of chest x-ray findings indicates neonatal pneumonia caused by group B beta-hemolytic streptococci (GBS)?

Diffuse reticulogranular pattern, opacity, patchy infiltrates, pleural effusion

Perihilar infiltrates; streaky, lobar consolidation; late-onset pleural effusion

Bilateral consolidation, lung abscess, pneumatocele

Diffuse infiltrates, abscess formation

Correct answer: Diffuse reticulogranular pattern, opacity, patchy infiltrates, pleural effusion

Neonatal pneumonia that is caused by GBS will show a diffuse reticulogranular pattern, opacity ("whiteout"), patchy infiltrates, and pleural effusion on a neonate's chest x-ray.

Perihilar infiltrates; streaky, lobar consolidation; and late-onset pleural effusion on an x-ray are all indicative of pneumonia caused by herpes virus. Pneumonia caused by Klebsiella bacteria will show bilateral consolidation, lung abscess, and pneumatocele on a chest x-ray. Diffuse infiltrates and abscess formation on a chest x-ray are indicative of neonatal pneumonia caused by MRSA (methicillin-resistant Staphylococcus aureus).

57.

All of the following may be used in the treatment of TTN (transient tachypnea of the newborn), EXCEPT:

Diuretic agents to eliminate excess lung fluid

CPAP

Antibiotic therapy with risk factors for infection

Mechanical ventilation

Correct answer: Diuretic agents to eliminate excess lung fluid

In general, support of an infant with TTN requires only sufficient supplemental oxygen to maintain an arterial oxygenation tension of more than 70 to 80 mm Hg and usual supportive neonatal care. Frequently, little more than general support is necessary while the normal absorption of lung fluid through the lymphatic system occurs. As the lung fluid clears, both the x-ray abnormalities and the clinical presentation of the infant resolve within 72 hours. Nasal CPAP or mechanical ventilation is generally well tolerated and effective.

Although diuretic agents have been advocated, a recent systematic review found no benefit and recommended against the use of oral or intravenous furosemide for the treatment of TTN. Empiric antibiotics are warranted only for infants with TTN who have risk factors for infection.

58.

What is an appropriate nursing intervention for an infant requiring supplemental oxygen via an oxygen hood?

Use a blender system to administer a fixed oxygen concentration

Implement no intervention

Switch the infant to a nasal cannula to ensure appropriate development of social and motor skills

Obtain an order and change the infant to nasal continuous positive airway pressure (CPAP)

Correct answer: Use a blender system to administer a fixed oxygen concentration

An oxygen hood fits over the infant's head to deliver a constant concentration of oxygen and is appropriate for cases of mild respiratory distress syndrome, transient tachypnea of the newborn, meconium aspiration, or pneumonia. A blender system is the most reliable way to administer a fixed oxygen concentration via a hood. Another source of oxygen must be provided when the infant's head is removed from the hood because of feeding, holding, or suctioning.

A nasal cannula is used for the dependent infant who is developing social and motor skills, particularly when being discharged home on supplemental oxygen. Nasal CPAP is not warranted if the infant demonstrates sufficient ventilation to maintain a normal PaCO2 value, as in the case of an infant requiring only an oxygen hood.

59.

When considering weaning an infant from the ventilator, which of the following parameters indicates improvement, thus supporting ventilatory weaning and extubation?

Supplemental oxygen ranging between 21% and 30%

Tidal volume values below 6 mL/kg

Progressively increasing FiO2 requirements

Peak inspiratory pressure of 18 to 22 cm H2O

Correct answer: Supplemental oxygen ranging between 21% and 30%

When ventilatory parameters are low, weaning an infant from the ventilator should be considered. Supplemental oxygen requirements ranging between 21% and 30% are indicative of improvement, and weaning would be indicated.

Tidal volume values above 6 mL/kg, increased activity and muscle tone in addition to progressively decreasing (not increasing) FiO2 requirements, and peak inspiratory pressures of 16 to 18 cm H2O all indicate an improving infant.

60.

Treatment for apnea of prematurity may include all the following, EXCEPT:

Norepinephrine

Tactile stimulation

Theophylline

Caffeine

Correct answer: Norepinephrine

Treatment of primary apnea, or apnea of prematurity, should begin with the least invasive intervention possible. Gentle tactile stimulation is often successful, especially with early recognition. When infants do not immediately respond to external stimuli, bag-and-mask ventilation must be initiated; low-pressure nasal CPAP or mechanical ventilation may be necessary if the infant fails to respond to other measures and continues to have repeated and prolonged apneic episodes.

Methylxanthines, such as caffeine citrate and theophylline, are used to treat apnea of prematurity and are used only for primary apnea when pathologic causes have been eliminated and when the infant fails to respond to lesser measures alone. These drugs reduce the frequency of apnea and are associated with a decrease in the use of mechanical ventilation.

61.

Which of the following should be initiated for infants born before 32 weeks of gestation to decrease the incidence of RDS?

A course of antenatal steroids

Surfactant replacement therapy

Nitric oxide therapy

Inositol therapy

Correct answer: A course of antenatal steroids

A single course of antenatal steroids (betamethasone or dexamethasone) decreases the incidence and severity of RDS, comorbid conditions, and mortality in infants born before 32 weeks of gestation. It is considered prophylactic therapy for infants born at or before 32 weeks.

Corticosteroid therapy is recommended for pregnant women between 24 and 33 6/7 weeks of gestation who are at risk of preterm delivery within 7 days, including those with ruptured membranes and multiple gestations, and may be considered starting at 23 weeks of gestation if there is a risk of preterm delivery within 7 days, irrespective of membrane status.

Treatment of RDS may involve the other choices.

62.

Hyperoxia in an infant is defined as a PaO2 above which value?

80 mm Hg

60 mm Hg

70 mm Hg

90 mm Hg

Correct answer: 80 mm Hg

Hyperoxia occurs when cells, tissues, and organs are exposed to an excess supply of oxygen (O2) or a higher partial pressure of oxygen in arterial blood (PaO2). An infant who is hyperoxic has a PaO2 of greater than 80 mm Hg (normal values are between 60 and 80 mm Hg). Therefore, monitoring of oxygen saturations and partial pressure of oxygen with arterial blood gases is mandatory whenever oxygen is administered to infants.

63.

What is the effect on an infant's blood gases when positive inspiratory pressure (PIP) is increased during mechanical ventilation?

Increased PaO2, decreased PaCO2, increased pH

Increased PaO2, increased PaCO2, decreased pH

Decreased PaO2, decreased PaCO2, increased pH

Decreased PaO2, increased PaCO2, decreased pH

Correct answer: Increased PaO2, decreased PaCO2, increased pH

If PIP is increased on a mechanical ventilator, the result will be an increase in PaO2, a decrease in PaCO2, and an increase in pH.

64.

Which of the following statements regarding a congenital diaphragmatic hernia (CDH) is TRUE?

CDH leads to a variable extent of pulmonary hypoplasia.

Morgagni diaphragmatic hernias account for nearly 95% of all CDH cases.

Early repair of CDH within 72 hours of birth is indicated for optimal outcomes.

With CDH, the anteroposterior diameter of the chest may be decreased.

Correct answer: CDH leads to a variable extent of pulmonary hypoplasia.

CDH is a defect in the closure of the diaphragm; it is a herniation of the abdominal viscera through the diaphragmatic defect in utero. This herniation impairs lung development, and compression of the developing lung leads to variable pulmonary hypoplasia.

*A posterolateral defect, or a **Bochdalek diaphragmatic hernia**, accounts for nearly 95% of all CDH and may be left-sided (95%) or right-sided (5%). Much less common is the Morgagni diaphragmatic hernia, which results from a failure of anteromedial closure in a substernal location. Surgical repair does not alter early outcomes. Therefore, a baby's condition should be stabilized, and efforts should be directed toward the management of the associated pulmonary hypoplasia and hypertension. Early repair within the first 72 hours after birth is indicated **only** for infants having little or no pulmonary dysfunction. With CHD, much of the bowel is herniated into the chest, and the abdomen appears scaphoid. The anteroposterior diameter of the chest may **enlarge** (not decrease) as the bowel distends with air. Breath sounds are diminished or absent on the affected side.*

65.

An infant is born vaginally at 41 weeks of gestation with meconium-stained fluid. The neonate is suspected of having aspirated meconium during delivery based on signs of respiratory distress immediately following delivery. The infant is deep suctioned, and meconium is extracted from their airway.

A chest x-ray would reveal which of the following findings indicating meconium aspiration syndrome (MAS)?

Streaky and patchy infiltrates

Either diffuse or focal infiltrates

Diffuse granularity with air bronchograms

Increased pulmonary vascularity or edema

Correct answer: Streaky and patchy infiltrates

Meconium-stained amniotic fluid is present in approximately 8% to 29% of all newborns delivered. Of these, between 3% and 12% develop MAS.

MAS is a disease of term or post-term infants; it is rarely seen in infants born before 36 weeks of gestation. Vigorous resuscitation is frequently needed in the delivery room because of central depression. Respiratory distress signs are nonspecific and can include tachypnea, nasal flaring, and retractions. Manifestations can range from mild and transient to severe and prolonged.

Chest imaging shows streaky and patchy infiltrates; hyperexpanded lucent areas mixed with areas of atelectasis throughout lung fields. Ancillary findings include air leak syndrome (i.e., pneumothorax).

Either diffuse or local infiltrates are indicative of neonatal pneumonia. Diffuse granularity with air bronchogram often signals hyaline membrane disease. Congenital heart disease will show increased pulmonary vascularity or edema on chest x-ray films.

66.

Worsening cyanosis of a post-term neonate in the first 24 hours after birth is often an initial clinical sign of which condition?

Persistent pulmonary hypertension of the newborn (PPHN)

Left-to-right shunting through the ductus arteriosus

Neonatal pneumonia

Transient tachypnea of the newborn (TTN)

Correct answer: Persistent pulmonary hypertension of the newborn (PPHN)

PPHN manifests as severe pulmonary hypertension with pulmonary artery pressure elevation to levels equal to systemic pressure or higher and large right-to-left shunts through the foramen ovale and ductus arteriosus. This condition manifests early in life, with a majority (77%) of cases being diagnosed in the first 24 hours after birth.

Initial clinical presentation is usually a late-preterm, term, or post-term infant with worsening cyanosis within the first 24 hours. Tachypnea is common and, when accompanied by retractions, is indicative of decreased pulmonary compliance.

Pneumonia results from bacterial, viral, mycoplasmal, or fungal infections acquired perinatally or postnatally and is due to immaturity of the immune system, colonization of the mother's genital and vaginal tracts with pathogens, amnionitis, prolonged rupture of membranes, and nosocomial infections acquired in the NICU. TTN generally occurs in term or late-preterm infants with a history of cesarean section or precipitous delivery. Lack of compression of the fetal chest during delivery results in retained fetal interstitial lung fluid.

67.

Oxyhemoglobin saturation is the percentage of hemoglobin that is combined with oxygen. Many factors decrease the affinity of hemoglobin for oxygen, causing the oxygen-hemoglobin dissociation curve to shift to the right.

All the following factors cause this shift to the right, EXCEPT:

Fetal hemoglobin

Fevers

Acidemia

Hypercapnia

Correct answer: Fetal hemoglobin

Oxygen binding with hemoglobin increases as the partial pressure of oxygen increases. The oxygen-dissociation curve is a measure of the affinity that hemoglobin has for oxygen. Fetal hemoglobin increases the affinity of hemoglobin for oxygen, shifting the curve to the left; the affinity of fetal hemoglobin for oxygen is higher than adult hemoglobin. Approximately 70% of hemoglobin in term infants, and more in preterm infants, consists of fetal hemoglobin.

Fevers, acidemia, and hypercapnia decrease the affinity of hemoglobin for oxygen, thus shifting the curve to the right.

68.

On a newborn assessment, the infant's elbow crosses the midline without resistance as the examiner draws the arm across the chest to the opposite shoulder. What does this finding indicate?

The infant is preterm

The infant is full-term

The infant likely has a clavicular fracture

The infant is hypertonic

Correct answer: The infant is preterm

The scarf sign on a physical exam is a part of the Ballard system, which incorporates physical maturity and neuromuscular maturity on an equal basis and includes assessments for extremely premature infants. The Ballard is performed shortly after birth to help determine developmental age and muscle tone in neonates.

When the arm is pulled laterally across the chest, the elbow will cross midline without resistance for a hypotonic infant, indicating prematurity. In a full-term infant with normal tone, the elbow will not reach the midline.

69.

Which test provides diagnostic confirmation of persistent pulmonary hypertension of the newborn (PPHN)?

Hyperoxia-hyperventilation test

Hyperoxia test

Pre- and post-ductal arterial blood sample comparison

Contrast echocardiography

Correct answer: Hyperoxia-hyperventilation test

The hyperoxia-hyperventilation test is the most definitive diagnostic assessment for PPHN. If PO_2 is below 50 mm Hg pre-hyperventilation and rises above 100 mm Hg, the diagnosis is PPHN.

The other tests will help give a clearer clinical picture but are not diagnostic of PPHN.

70.

Which of the following drugs is classified as a phosphodiesterase inhibitor and used to treat persistent pulmonary hypertension of the newborn (PPHN)?

Milrinone (Primacor)

Dobutamine

Theophylline

Inhaled nitric oxide (iNO)

Correct answer: Milrinone (Primacor)

Milrinone is a class III phosphodiesterase inhibitor with inotropic, lusitropic (myocardial relaxation), and vasodilator properties and is used to treat PPHN. It improves oxygenation (without compromising systemic blood pressure) by increasing PaO2, reducing FiO2, decreasing oxygen index and MAP, and improving base deficit(s) and plasma lactate levels. It is used for term and late-preterm neonates with PPHN who are nonresponders or have a suboptimal response to iNO.

71.

Apnea of prematurity may be classified as all the following, EXCEPT:

Tangential apnea

Obstructive apnea

Central apnea

Mixed apnea

Correct answer: Tangential apnea

Apnea is the cessation of breathing for 20 seconds or longer or cessation of breathing for 15 seconds with cyanosis and/or bradycardia. Apnea of prematurity or primary apnea is not associated with other specific disease entities. The younger a patient's gestational age is, the greater their incidence of apnea.

Apnea is traditionally classified as central (absence of breathing effort), obstructive (breathing efforts occur, but the airway is blocked), or—most commonly—mixed (initial central apnea followed by obstruction of the airway). Various conditions can cause apnea, including infection, respiratory distress, cardiovascular diseases, GI and/or metabolic disorders, and neuronal immaturity.

72.

For infants with respiratory distress syndrome (RDS), what do grunting, nasal flaring, and chest retractions represent?

An attempt to maintain a normal functional residual capacity (FRC)

An attempt to conserve energy

An attempt to decrease upper airway resistance

An attempt to overcome airway obstruction

Correct answer: An attempt to maintain a normal functional residual capacity (FRC)

For infants with RDS, their immature lung anatomy and physiology cannot support oxygenation and ventilation, and functional residual capacity is reduced. The diaphragm contracts, creating an inspiratory pressure that moves less volume into the lungs than expected and simultaneously causes large sternal and intercostal retractions of the chest wall. In addition, infants with RDS are often tachypneic and demonstrate grunting, along with pallor or cyanosis.

Energy conservation is important for sick infants and is typically demonstrated by decreased tone and activity. Upper airway resistance is a function of nasal resistance and the cartilage supporting structures of the pharyngeal airway. Large airway obstruction is caused by mucus or congenital defects and is not relieved by grunting, flaring, or retracting.

73.

A nurse is auscultating the lungs of an infant who has just been intubated. They hear continuous low-pitched breath sounds during both inspiration and expiration that are more prominent on expiration. What adventitious breath sound is described?

Rhonchi

Rales

Crackles

Wheezes

Correct answer: Rhonchi

Rhonchi are often a low-pitched moan that sounds more prominent on exhalation. Wheezes are high and squeaky (usually heard on exhalation, reactive airway), while these are low and dull. Rhonchi are caused by blockages to the main airways by mucus, lesions, or foreign bodies. Rhonchi improve or resolve with coughing or suctioning.

Crackles and rales are the same thing and are the sounds heard in a lung field that has fluid in the small airways.

74.

What is an early sign of respiratory distress in an infant?

Grunting and nasal flaring

Hypertension

Respiratory rate of 45-60 breaths/minute

Pallor or cyanosis

Correct answer: Grunting and nasal flaring

Infants with respiratory distress syndrome (RDS) are often tachypneic (respirations of 60 or greater) and exhibit grunting, nasal flaring, and chest retractions within the first few minutes to hours after birth as the infant attempts to compensate for impaired lung function.

Pallor or central cyanosis also may be present as a later sign. Chest auscultation reveals decreased breath sounds and often rales. Many of these infants may also be hypotensive (not hypertensive) with prolonged capillary refill.

75.

Which of the following factors confers a high risk of respiratory distress syndrome (RDS)?

Lecithin-sphingomyelin (L/S) ratio below 2:1

Lecithin-sphingomyelin (L/S) ratio above 2:1

Phosphatidylglycerol (PG) with blood-contaminated amniotic fluid

Lecithin-sphingomyelin (L/S) ratio of 3:2

Correct answer: Lecithin-sphingomyelin (L/S) ratio below 2:1

Reflecting the movement of lung fluid and its components (notably lecithin) into amniotic fluid, the lecithin-sphingomyelin (L/S) ratio has become an important clinical tool. In general, an L/S ratio above 2:1 indicates fetal lung maturity, whereas ratios below 2:1 are associated with RDS.

PG, the second most common phospholipid in surfactant, appears at approximately 36 weeks of gestation and increases until term. The presence of PG is associated with a low risk for RDS, but its absence is associated with the development of RDS. Unlike the L/S ratio, PG determination is valid in the presence of blood-contaminated amniotic fluid.

76.

Which lung field is MOST OFTEN affected in the diagnosis of congenital lobar emphysema?

Left upper lobe

Right upper lobe

Right lower lobe

Left lower lobe

Correct answer: Left upper lobe

Congenital lobar emphysema is a neonatal condition associated with trapped air and subsequently enlarged air spaces in the lungs of newborns at birth; it most commonly affects the left upper lobe. It can be associated with multiple causes, resulting in obstructive emphysema.

It has two forms:

- ***hypoalveolar:*** *affecting fewer than the expected number of alveoli*
- ***polyalveolar:*** *affecting more than the expected number of alveoli*

The affected lobe is overdistended, and there is a mediastinal shift noted on x-ray to the contralateral side of the chest. This respiratory condition must be managed surgically because it compromises functional lung volume.

77.

Continuous positive airway pressure (CPAP) is MOST often delivered by which of the following methods?

Nasal prongs

Facemask

Nasal pharyngeal tubes

Endotracheal (ET) tube

Correct answer: Nasal prongs

CPAP may be delivered by facemask, nasal pharyngeal tubes, nasal prongs, or ET tube. The delivery of CPAP by nasal prongs is the most common method.

The use of short binasal prongs is the most effective. Choosing the correct size of nasal prongs is important to avoid movement and erosion of nasal tissue for infants.

78.

An infant with a diagnosis of meconium aspiration syndrome (MAS) must be monitored closely for which of the following potential complications?

Persistent pulmonary hypertension of the newborn (PPHN)

Bronchopulmonary dysplasia (BPD)

Transient tachypnea of the newborn (TTN)

Hyperglycemia and hypercalcemia

Correct answer: Persistent pulmonary hypertension of the newborn (PPHN)

The use of new treatments has decreased the mortality rate to below 5% for infants with MAS. Persistent pulmonary hypertension frequently complicates MAS, potentiates the difficulties in oxygenation, and contributes to much of the mortality associated with MAS. Air-leaks (pneumothorax and pneumomediastinum) due to ball-valve phenomenon leading to overinflation and air-trapping and high ventilator pressures are complications of both the disease and the treatment.

Other potential complications include pneumonia, metabolic acidosis, hypoglycemia, and hypocalcemia. There is an increased risk for adverse neurologic outcomes (cerebral palsy and global delays) and long-term pulmonary problems (increased airway reactivity, abnormal pulmonary function).

79.

Which of the following acid-base disorders often accompanies shock and septicemia in infants?

Metabolic acidosis

Respiratory acidosis

Metabolic alkalosis

Respiratory alkalosis

Correct answer: Metabolic acidosis

Metabolic acidosis, in which too much acid accumulates in the body, is common among infants in shock and septicemia.

The anion gap and urine electrolytes should be obtained to provide additional insight into the underlying pathophysiology. In addition, blood pressure measurement, a complete blood cell count, serum and urine electrolytes and pH, serum albumin and glucose determinations, and assessment of intake and output of fluids are often needed to identify the source of metabolic acidosis.

80.

Bronchopulmonary dysplasia (BPD) occurs predominantly in infants who are born under which circumstances?

Prematurely

At or near term

With preexisting lung disease

Weighing less than 2500 g

Correct answer: Prematurely

BPD is a disorder of primarily premature infants that is characterized by respiratory distress and impaired gas exchange. It is an iatrogenic disease caused by oxygen toxicity and barotrauma resulting from pressure ventilation. It can occur in infants with a family history, genetic susceptibility, and even mild or no initial lung disease in the first week after birth. However, it generally affects infants with severe lung disease complicated by an air leak, patent ductus arteriosus, and/or infection.

81.

Which of the following statements about ventilation-perfusion matching is TRUE?

The most common lung abnormality in newborns is mismatched ventilation and perfusion.

An intrapulmonary shunt is represented by ventilated and oxygenated alveoli without perfusion.

Perfused but nonventilated alveoli represent wasted ventilation.

The ideal ventilation-perfusion ratio is zero.

Correct answer: The most common lung abnormality in newborns is mismatched ventilation and perfusion.

In newborns, there is always some degree of ventilation and perfusion mismatch. Two extreme examples are:

- *ventilated and oxygenated alveoli without perfusion (i.e., pulmonary emboli), representing wasted ventilation*
- *perfused but nonventilated alveoli (i.e., atelectasis), representing an intrapulmonary shunt*

Either extreme is incompatible with life. Clinically relevant degrees of ventilation-perfusion mismatch will lie somewhere between those extremes.

*Matching ventilation and perfusion is required for efficient gas exchange. Mismatching is the **most** common cause of hypoxia. A ventilation-perfusion ratio of zero indicates a shunt; no ventilation takes place as blood passes through the lungs. The ideal ratio is 1:1, as ventilation is perfectly matched to perfusion.*

82.

What is the MOST effective strategy to prevent retinopathy of prematurity (ROP) in very-low-birth-weight (VLBW) infants?

Implement lower oxygen-saturation target guidelines

Implement higher oxygen-saturation target guidelines

Raise limits on oxygen-saturation alarms

Monitor arterial blood gases

Correct answer: Implement lower oxygen-saturation target guidelines

Evidence-based research shows that implementing oxygen-targeting guidelines in VLBW infants greatly reduces severe ROP; a systematic review and meta-analysis performed in 2011 found a 50% reduction in severe ROP when a lower (85% to 89%) rather than a higher oxygen saturation range was utilized. Higher saturation targets (91% to 95%) are associated with more ROP in extremely premature infants.

Lowering—not raising—limits on oxygen saturation alarms can decrease the incidence of ROP. Monitoring arterial blood gases shows the oxygen level at just one point in time; therefore, continuous pulse oximetry is the preferred method to monitor oxygen levels.

83.

Consistently high oxygen saturations in a neonate receiving supplemental oxygen can cause which complication?

Retinopathy of prematurity (ROP)

Respiratory alkalosis

Atelectasis

Pneumonia

Correct answer: Retinopathy of prematurity (ROP)

High levels of oxygen have been associated with ROP. Because pulse oximetry saturations higher than 92% can often be associated with hyperoxia, observational and cohort studies have demonstrated a significant reduction in the incidence of ROP and BPD/CLD in preterm infants when their oxygen saturations were maintained in a lower (SpO2 89% to 94%) rather than a higher range (SpO2 96% to 99%). Better oxygen level monitoring has led to better control of oxygen administered to premature infants.

The other choices are not generally associated with high oxygen saturations.

84.

A chest radiograph of a premature infant shows coarse granular infiltrates that are dense enough to obscure the cardiac markings in the first 3 to 10 days after birth. This finding is consistent with what stage of bronchopulmonary dysplasia (BPD)?

Stage II

Stage I

Stage III

Stage IV

Correct answer: Stage II

This chest x-ray finding is consistent with Stage II BPD, or chronic lung disease (CLD). X-ray findings correlate with the stage of disease, but the pathologic changes are often more severe than the chest x-ray findings indicate.

Stage I occurs in the first three days of life and is characterized by a reticulogranular pattern and air bronchograms, or RDS.

Stage III BPD develops in the first 10 to 20 days after birth and is characterized by multiple small cyst formations within the opaque lungs and visible cardiac borders.

Finally, Stage IV BPD consists of irregular larger cyst formation that alternates with areas of increased density, occurring after 28 days from birth.

85.

Administration of surfactant to an infant with respiratory distress syndrome (RDS) leads to all the following, EXCEPT:

Reduction in pulmonary vascular resistance (PVR)

Reduction in surface tension

Improvement in gas exchange

Decreased need for high levels of supplemental oxygen

Correct answer: Reduction in pulmonary vascular resistance (PVR)

Surfactant administration leads to the following:

- *reduction in surface tension*
- *dramatic and rapid improvement in gas exchange*
- *decreased need for high levels of supplemental oxygen and ventilatory support*
- *less barotrauma*
- *improved chest x-ray findings because of improved lung compliance and lung volume*

Treatment of persistent pulmonary hypertension of the newborn (PPHN) focuses on reducing PVR by pulmonary vasodilation and increasing SVR by maintaining adequate oxygenation.

86.

What is an action of nitric oxide?

Relaxes vascular smooth muscle

Increases pulmonary vascular resistance

Releases phagocytes

Increases blood pressure

Correct answer: Relaxes vascular smooth muscle

Nitric oxide (NO) is a molecule released from the endothelium that enables vascular smooth muscle relaxation (hence the term "endothelium-derived relaxing factor"). NO is avidly bound by hemoglobin in red blood cells and is inactivated after the metabolism of nitrite and nitrate. It has no direct effects on systemic arterial pressure (blood pressure). Because NO inhibits platelet aggregation, potential toxicities include hemorrhage and methemoglobinemia.

Inhaled NO has been approved by the US Food and Drug Administration (FDA) for treatment of late-preterm (>34 weeks of gestation) and term neonates with persistent pulmonary hypertension (PPHN).

87.

Which of the following pharmacologic agents used in the treatment of chronic lung disease (CLD) is the drug of choice for bronchospasm?

Albuterol (Proventil, Ventolin)

Histamine inhibitors (Cromolyn)

Terbutaline (Brethine)

Theophylline

Correct answer: Albuterol (Proventil, Ventolin)

Albuterol, a beta2-agonist, is the drug of choice for bronchospasms and is commonly used in the treatment of CLD and BPD (bronchopulmonary dysplasia); it is an inhaled bronchodilator that works by improving pulmonary resistance and lung compliance by bronchial smooth muscle relaxation.

Nurses should monitor affected infants closely for adverse effects, including tachycardia, tremors, nausea and vomiting, and irritability.

88.

An infant has a prenatal history of polyhydramnios. Soon after birth, the infant has excessive salivary secretions. Upon breastfeeding, they become dusky with respiratory distress, coughing, and regurgitating and require suctioning.

What is the MOST likely cause of this infant's respiratory distress?

Esophageal atresia with tracheoesophageal fistula

Choanal atresia

Diaphragmatic hernia

Congenital heart disease

Correct answer: Esophageal atresia with tracheoesophageal fistula

Maternal polyhydramnios may suggest esophageal atresia with tracheoesophageal fistula. These babies are identified soon after birth because of excessive salivary secretions and an inability to swallow feedings. Upon feeding, they quickly cough and regurgitate undigested milk; when attempting to pass an orogastric tube or suction tube, obstruction is generally met between 8 and 12 cm from the lips, and the diagnosis is established.

Choanal atresia is a membranous or bony obstruction of one or both nares and is characterized by noisy breathing, cyanosis, and apnea if the mouth is closed. Diaphragmatic hernia is typically diagnosed prenatally on ultrasound. Respiratory distress develops soon after birth and may present with significant pulmonary hypoplasia. The abdomen will appear scaphoid, and the AP diameter of the chest may enlarge as the bowel distends with air. Diminished or absent breath sounds are noted on the affected side. Most infants with congenital heart disease do not have respiratory distress.

89.

During fetal lung development, at what gestational age does phosphatidylglycerol (PG) peak, and a dramatic increase in the principal surfactant compound phosphatidylcholine occur?

34-36 weeks

24-26 weeks

26-28 weeks

30-32 weeks

Correct answer: 34-36 weeks

In utero, fetal lung development undergoes numerous stages and events in preparation for extrauterine life. PG is the second most common phospholipid in surfactant, peaking at approximately 34-36 weeks of gestation and increasing until term. At this stage in fetal lung development, a dramatic increase in the principal surfactant compound phosphatidylcholine occurs as well.

The presence of PG is associated with a low risk of respiratory distress syndrome (RDS), while the absence of PG could indicate RDS in an infant. PG determination is valid in the presence of blood-contaminated amniotic fluid.

90.

Hypoxemia is BEST described as which of the following?

An abnormally low level of oxygen in arterial blood

An abnormally low level of oxygen at the cellular level

An abnormally low level of oxygen in venous blood

An abnormally low level of oxygen binding with hemoglobin

Correct answer: An abnormally low level of oxygen in arterial blood

Normal PaO2 (partial pressure of oxygen) is 80 to 100 mm Hg; it reflects the amount of oxygen gas dissolved in arterial blood. It primarily measures the effectiveness of the lungs in pulling oxygen into the bloodstream from the atmosphere. Thus, in arterial blood, 80 to 100 mm Hg represents the "amount" of oxygen that is dissolved in each 100 mL of the arterial blood.

91.

The most common chest x-ray findings associated with persistent pulmonary hypertension of the newborn (PPHN) include all the following, EXCEPT:

Signs of right ventricular dysfunction

Moderate cardiomegaly

Variable pulmonary vasculature

Prominent main pulmonary artery segment

Correct answer: Signs of right ventricular dysfunction

PPHN manifests as severe pulmonary hypertension with pulmonary artery pressure elevation to levels equal to systemic pressure or higher and large right-to-left shunts through the foramen ovale and ductus arteriosus. Common chest x-ray findings include:

- *prominent main pulmonary artery segment*
- *mild to moderate cardiomegaly*
- *variable pulmonary vasculature (increased, decreased, or normal)*
- *signs of **left ventricular** (not right) dysfunction including pulmonary venous congestion and cardiomegaly*

92.

The first breath after birth requires a specific amount of opening pressure to overcome the surface tension of the air-liquid interface within the fetal lungs. What range does the opening pressure need to be to do this effectively?

60 to 80 cm H2O

50 to 70 cm H2O

70 to 90 cm H2O

40 to 60 cm H2O

Correct answer: 60 to 80 cm H2O

An opening pressure of 60 to 80 cm H2O is required to overcome the effects of the surface tension of the air-liquid interface, particularly in the small airways and alveoli. Thus, with each subsequent breath, less pressure is necessary to allow for a similar increase in air volume in the lung, so the work of breathing is lessened with subsequent breaths.

93.

Which of the following is characterized by active inspiration and expiration in an infant?

High-frequency oscillatory ventilation (HFOV)

Conventional mechanical ventilation (CMV)

Synchronized intermittent mandatory ventilation (SIMV)

Spontaneous respirations

Correct answer: High-frequency oscillatory ventilation (HFOV)

HFOV uses active inspiration and expiration; gas is pushed into the lung during inspiration and pulled out during expiration with the electromagnetically driven diaphragm used in HFOV. It generates very low tidal volumes that are generally less than the dead space of the lung.

With spontaneous respirations, inspiration is active, and expiration is passive. CMV utilizes active inspiration and passive expiration.

SIMV, a commonly used form of patient-triggered ventilation, delivers mechanical breaths at a fixed rate; it enables synchronization of ventilation breaths by sensing a neonate's initiation of respiration and then triggering a mechanical breath.

94.

When an infant is on mechanical ventilation, PEEP is an important parameter to monitor. What is PEEP?

Maximum pressure that provides continuous distension of the lungs

Maximum pressure used during inspiration

Set number of mechanical breaths administered in a minute

Set time for inspiration during a breath

Correct answer: Maximum pressure that provides continuous distension of the lungs

Peak (or positive) end-expiratory pressure (PEEP) is a mode of therapy used in conjunction with mechanical ventilation. At the end of mechanical or spontaneous exhalation, PEEP maintains an infant's airway pressure above the atmospheric level by exerting pressure that opposes passive emptying of the lung. This pressure is typically achieved by maintaining a positive pressure flow at the end of exhalation and is measured in centimeters of water (usually between 6 and 8 cm H_2O). PEEP aids in maintaining functional residual capacity (FRC), stabilizing and recruiting atelectatic areas for gas exchange, improving compliance, and improving ventilation-perfusion matching in the lungs.

PIP (peak inspiratory pressure) is the maximum pressure utilized during inspiration. Consider the tidal volume (VT) achieved to determine a suitable PIP (VT is usually around 4-5 mL/kg).

Respiratory rate (RR) is the set number of mechanical breaths administered in a minute. Usually between 40-60. In SIMV (synchronized intermittent mandatory ventilation), the set RR is both the maximum and minimum rate; in A/C ventilation, the RR is the minimum but not the maximum rate.

Inspiratory time (Ti) is the set time for inspiration during a breath, which is usually 0.3-0.5 seconds.

95.

Continuous positive airway pressure (CPAP) is MOST likely to be indicated in which of the following diagnoses?

Obstructive apnea

Central apnea

Persistent pulmonary hypertension of the newborn (PPHN)

Pneumothorax

Correct answer: Obstructive apnea

Obstructive apnea responds to low-pressure (3-5 cm H_2O) nasal CPAP because it stabilizes the chest wall and splints the airways and diaphragm.

Central apnea is not responsive to CPAP. PPHN responds best to high-frequency ventilation (HFV). Air leak syndromes, such as pneumothorax, may worsen with CPAP therapy due to increased end-expiratory pressure.

96.

An infant is receiving methylxanthine therapy for apnea of prematurity. For which of the following symptoms indicating toxicity should the nurse monitor?

Tachycardia

Oliguria

Hypertension

Sedation

Correct answer: Tachycardia

Methylxanthines such as caffeine, theophylline, and aminophylline are used to treat apnea of prematurity. They are potent cardiac, respiratory, and CNS stimulants and smooth muscle relaxers. Their effect on decreasing the frequency of apnea is related to central stimulation of brainstem respiratory neurons rather than to changes in pulmonary function.

Nurses must monitor for symptoms of toxicity while an infant is being treated with methylxanthines, such as myocardial stimulation (tachycardia and hypotension), hyperactivity (restlessness, irritability, and wakefulness), diuresis (not oliguria), and vomiting.

97.

Which of the following statements about peak inspiratory pressure (PIP) is ACCURATE for a ventilated neonate?

PIP is more likely to cause air leaks for a ventilated neonate than positive end-expiratory pressure (PEEP).

Overdistention of the lungs caused by excessive pressure worsens acute lung injury.

Evidence strongly suggests that lung injury results from deficient tidal volume (insufficient PIP).

Levels of PIP that are too low contribute to hypoxia and pulmonary hypertension because of low lung volumes.

Correct answer: PIP is more likely to cause air leaks for a ventilated neonate than positive end-expiratory pressure (PEEP).

PIP is the maximum pressure measured during gas delivery (inspiration) via conventional mechanical ventilation; it reflects the effects of the amount of gas delivered to the lungs in an administered breath and the underlying mechanical properties of the lungs. PIP is more likely to cause air leaks than PEEP for a ventilated infant.

Evidence strongly suggests that lung injury results from excessive tidal volume (excessive PIP), not by excessive pressure. It would be difficult to overexpand the lungs with PEEP to the point of air leak. High PEEP (not PIP) in the presence of relatively compliant lungs will cause overdistention, worsen PaO2, and increase PVR.

Levels of PEEP (not PIP) that are too low contribute to hypoxia and pulmonary hypertension because of low lung volumes; too little PEEP is far more often the cause of air leaks.

98.

A nurse assesses an infant immediately following delivery. Upon auscultation of the lungs, the nurse hears peristaltic sounds over the chest. What does this finding indicate?

Diaphragmatic hernia

Pneumomediastinum

Atelectasis

Pneumonia

Correct answer: A diaphragmatic hernia

Peristaltic sounds heard in the chest may be caused by a diaphragmatic hernia, as much of the bowel is herniated into the chest. The abdomen appears scaphoid, and the anteroposterior diameter of the chest may enlarge as the bowel distends with air. Breath sounds are diminished or absent on the affected side, and the mediastinum may be displaced toward the contralateral side.

Hyperresonance suggests a pneumomediastinum (air in the mediastinum). Decreased resonance is a result of reduced aeration (e.g., atelectasis, pneumonia, or respiratory distress syndrome).