THERAPIST MULTIPLE-CHOICE/ CLINICAL SIMULATION EXAM REVIEW WORKSHOP

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RESPIRATORY REVIEW WORKSHOPS, INC

TMC Examination

- 160 Multiple-choice questions
  - 140 scored; 20 pretest items
- 3 major content areas
  - Clinical data, equipment, therapeutic procedures
- 3 hour time limit
  - Track your progress
    - #60 by the end of the first hour

High cut score – 94, low cut score - 88

TMC Examination

- Type of questions
  - Recall – the ability to recall or recognize specific respiratory care information (31 questions)
  - Application – the ability to comprehend, relate, or apply knowledge to new or changing situations (61 questions)
  - Analysis – the ability to analyze information, put information together to arrive at solution, or evaluate the usefulness of the solutions (48 questions)

RRT Examination (Clinical Simulation)

- 22 simulations
  - 20 count toward the grade
- Scenarios are designed to flow just like a real patient case
  - The same way data is delivered and care decisions are made in the hospital setting
- Branching logic format
  - You will choose your own path
    - But only one path is the best
    - There will be others that are acceptable
    - As well as those that are unacceptable
- 4 hour time limit
  - 6 per hour

NBRC Matrix

- The test matrix indicates the areas tested on the exams
- This review is designed as a matrix based approach
  - Provides example test questions and information pertinent to examination success

Test Preparation Strategies

- Study, study, study
  - BUT DON'T CRAM!
- Take as many practice exams as possible
  - This will allow you to identify weaknesses
- Know where the testing center is (consider traffic)

Test Preparation Strategies

- Eat a good dinner the night before, avoiding alcohol
- Do not cram the night before
  - If you're not ready by now, cramming won't help
  - Instead try to relax
- Sleep well
  - Plan to get up early with an alarm
  - Avoid sleeping pills
- Allow time for a good breakfast
  - That will get you through lunch
- Minimize caffeine
  - The adrenaline will be pumping

I. Patient Data Evaluation and Recommendations (55 questions)

A. Evaluate Data in the Patient Record (8 questions)

Compliance

- $C_{LD} = \dfrac{\text{tidal volume}}{\text{PIP} - \text{PEEP}}$
- $C_{LS} = \dfrac{\text{tidal volume}}{\text{plateau} - \text{PEEP}}$
- **When plateau pressure *increases* with no change in tidal volume, lung compliance *decreases*. When PIP *increases* with no change in tidal volume or plateau pressure, airway resistance is *increasing*.**

Hypokalemia

- Refers to a potassium level of <3.5 mEq/L
- Usually results from diuretic therapy, vomiting, diarrhea or severe trauma

- **Normal serum potassium (K^+) level**
  - **3.5 - 5 mEq/L**

Hypokalemia

- Clinical Symptoms
  - Muscle weakness resulting in respiratory failure, paralysis and hypotension
  - Cardiac arrhythmias (PAC, PVC, V-tach)
  - S-T segment depression on ECG

Obstructive Lung Disorders

- Pulmonary Function Results
  - Decreased flows (FEV1, FEF 25-75%)
  - Increased FRC, RV, TLC
- An FEV1/FVC of < 70% will always indicate obstructive disease
- Examples: emphysema, chronic bronchitis, bronchiectasis, CF, asthma

Restrictive Lung Disease

- Pulmonary Function Results
  - Decreased volumes
  - Decreased capacities
  - Normal flow studies
- Examples: pulmonary fibrosis, pneumonia, atelectasis, kyphoscoliosis

Response to Bronchodilators

- Significant response to a bronchodilator indicated by:

- 12% or more increase in the FEV_1 or FVC
- FVC increases by > 200 mL

ABG Interpretation

pH 7.43
$PaCO_2$ 29 torr
PaO_2 70 torr
HCO_3 18 mEq/L

- **Fully compensated respiratory alkalosis, mild hypoxemia**

Calculating Total Oxygen Content (CaO2)

- Hb = 1.34 x Hb x SaO_2
- Plasma = .003 x PaO_2

- On exam, don't calculate how much is dissolved in the plasma since it's always less than 1.
- Calculate how much is bound to Hb and pick the answer closest to that number but just higher.

- **NOTE - Remember to use the fractional concentration for the SaO_2; for example 95%, use 0.95**

Dynamic vs. Static Compliance

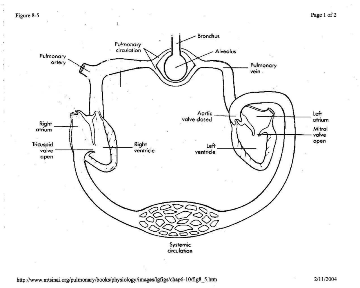
- Dynamic compliance is always lower than static compliance because the PIP is used to calculate dynamic compliance. Plateau is used to calculate static compliance. Plateau is always lower than PIP.

Pulmonary Capillary Wedge Pressure

- Measurement of left atrial pressure
- Normal value: 5-10 mm Hg
- Value increases due to:
  - Left ventricular failure
  - Systemic hypertension
  - Mitral or aortic valve stenosis

- An increased PCWP that results in pulmonary edema is referred to as ***cardiogenic*** pulmonary edema.

Pulmonary Capillary Wedge Pressure



COPD Patient's Blood Gas

pH	7.23
$PaCO_2$	82 torr
PaO_2	76 torr
HCO_3	36 mEq/L
B.E.	+12 mEq/L

- **To determine the "normal" $PaCO_2$ of a chronically hypercapnic emphysema patient look at the pH. If the pH is 7.30 or higher you know the $PaCO_2$ is normal for that patient. This $PaCO_2$ is above normal**

COPD Patient's Blood Gas

pH	7.23
$PaCO_2$	82 torr
PaO_2	76 torr
HCO_3	36 mEq/L
B.E.	+12 mEq/L

- **If the sum total of the $PaCO_2$ and PaO_2 is more than 140, the patient must be breathing supplemental oxygen**

Hyperventilation vs. Tachypnea

- **Hyperventilation is not a high respiratory rate.**
- **Tachypnea is an above normal respiratory rate.**
- **Hyperventilation is breathing in excess of metabolic needs and is *only detected* by observing a $PaCO_2$ of less than 35 torr.**

Hyperresonant Percussion Note

- Heard over the following
  - Hyperinflated lung tissue
  - Pneumothorax
  - Air-filled stomach

Cor Pulmonale

- Refers to right ventricular hypertrophy or right heart failure.
- Often the result of pulmonary hypertension which causes right atrial pressure (CVP) to increase.
- The elevated CVP prevents venous blood from entering the right atrium causing the ankles and jugular veins to engorge with blood

Central Venous Pressure (CVP)

- Measurement of right atrial pressure and right ventricular preload
- Normal value is 2-6 mmHg
- CVP increases due to pulmonary hypertension, right ventricular failure, pulmonary embolus, pulmonary valve stenosis, hypervolemia

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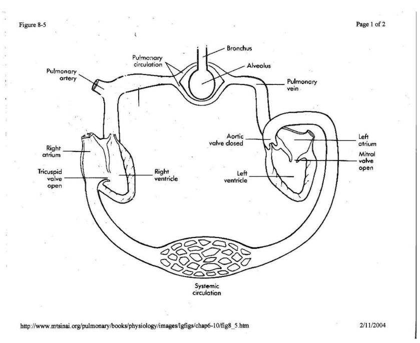
Central Venous Pressure



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Indications for Ventilatory Assistance

- VC < 10-15 mL/kg
- MIP > -20 cm H_2O
- A-a gradient > 450 torr on 100% O_2
- $PaCO_2$ > 50 torr
- V_D/V_T > 0.60

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I. Patient Data Evaluation and Recommendations (55 questions)

B. Gather Clinical Information (13 questions)
C. Perform Procedures to Gather Clinical Information (12 questions)
D. Evaluate Procedure Results (11 questions)
E. Recommend Diagnostic Procedures (11 questions)

Calculating Alveolar Minute Ventilation

- $V_E = (V_T - V_D)$ x respiratory rate
- **Note: Deadspace equals 1 mL/lb. of ideal body weight in the non-intubated patient; 1 mL/kg of ideal body weight in trached patient.**

(500 mL – 165) x 12 = 335 mL or .335 L x 12 = 4.0 L

ET TUBE PLACEMENT

- Carina located on CXR at level of 4^{th} rib and 4^{th} thoracic vertebra
- Tip of ET tube should be 2-5 cm above carina
- Tube should be taped at the lip at 21-25 cm (2 cm less for women)

ET Tube Cuff Care

- Use high-volume, low-pressure cuffs ("floppy")
- To ensure the cuff is exerting the least amount of pressure on the tracheal wall yet still providing an adequate seal, maintain cuff pressure between 20-30 cm H_2O

Transcutaneous O2 Monitoring (tcPaO2)

- Skin probe heated to 42° - 44°C
- Change position every 4 hours
- Calibrate with each position change: (while off baby)
  $(P_B – 47 \text{ mm Hg}) \times .21$
- Often used in pre- and post-ductal O_2 studies to help determine PPHN and R-L anatomical shunt

Weaning a COPD Patient

A. pH 7.34 $PaCO_2$ 75 torr PaO_2 45 torr

B. pH 7.47 $PaCO_2$ 60 torr PaO_2 64 torr

C. pH 7.51 $PaCO_2$ 58 torr PaO_2 42 torr

D. pH 7.29 $PaCO_2$ 65 torr PaO_2 85 torr

Determining Optimal PEEP

PEEP	PIP	Plateau	Vt
5	37	23	500
8	41	25	500
11	45	27	500
14	48	31	500

- **Optimal PEEP is the level of PEEP that results in the best static lung compliance.**

VD/VT RATIO

VD/VT = $\frac{PaCO_2 - PECO_2}{PaCO_2} = \frac{50 - 30}{50} = \frac{20}{50} = 0.40$

- **In other words, 40% of the patient's 600 mL Vt is not taking place in gas exchange. Deadspace volume then equals:**
- **600 mL x 0.40 = 240 mL**

Calculating A-a Gradient

- **Calculate P_AO_2 using alveolar air equation**
  $[(P_B - 47) \times FIO_2] - (PaCO_2 \times 1.25)$

Short cut equation: $(7 \times O_2\%) - (PaCO_2 + 10)$
$= (7 \times 40) - (42 + 10)$
$= 280 - 52$
= 228 torr

- **Subtract PaO_2 from P_AO_2.**
  228 - 90 = 138 torr

Select closest answer on the exam!

Indications for Ventilator Weaning

- MIP of at least -20 cm H_2O
- VC > 10-15 mL/kg
- Spontaneous V_T at least 5-6 mL/kg (IBW)
- RSBI (rate/V_T) < 105
- VD/VT < 0.60
- $P(A\text{-}a)O_2$ < 350 mm Hg on 100% oxygen
- PaO_2/F_IO_2 > 200
- PEEP < 10 cm H_2O

Determining Optimal PEEP

PEEP (cm H_2O)	PvO_2 (torr)	PaO_2 (torr)
3	35	65
6	37	70
9	39	74
12	33	79

- An indication that cardiac output has decreased is a drop in PvO_2.
- Optimal PEEP is the level of PEEP that results in the highest PvO_2.

Calculating Static Lung Compliance

$$\text{Static } C_L = \frac{\text{tidal volume}}{\text{plateau - PEEP}}$$

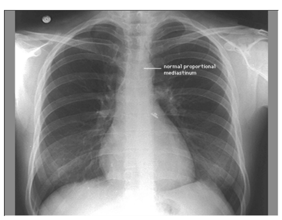
$$\text{Static } C_L = \frac{600}{25-5} = \frac{600}{20} = 30 \text{ mL/cm } H_2O$$

Carbon Monoxide Inhalation

pH	7.21
$PaCO_2$	25 torr
PaO_2	320 torr
HCO_3	15 mEq/L
B.E.	-10 mEq/L
SaO_2	65%

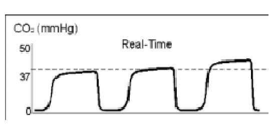
Initial Assessment of CXR

- Think RIP
  - Rotation – Is the patient positioned correctly? Spine should be between the clavicles
  - Inspiration – diaphragm between 9th and 11th rib
  - Penetration – should see the vertebral processes behind the heart



End-Tidal CO_2 Monitoring

- Measured at end exhalation
- Should trend with the $PaCO_2$ (within 2-5mmHg)
- If the $PaCO_2$-$P_{ET}CO_2$ gradient is increased it is usually indicative of deadspace (pulmonary embolism)



Co-oximetry (Hemoximetry)

- Used to assess hemoglobin saturation
  - O2HB
  - COHB
  - METHB
  - RHB
- If any other value besides O2HB increases, tissues can become hypoxic.

Co-oximetry (Hemoximetry)

- Causes of increased COHB
  - House fire or other forms of carbon monoxide exposure
- Causes of increased METHB
  - Nitric oxide administration, nitrate exposure, benzene exposure
  - Can give blood a chocolate brown color

II. Troubleshooting and Quality Control of Equipment, and Infection Control (20 questions)

A. Assemble and Troubleshoot Equipment (15 questions)

Incentive Spirometry

- Often referred to as sustained maximal inspiratory therapy (SMI therapy)
  - Slow inspiration causes even distribution
  - Breath hold causes alveolar recruitment
- Measures the patient's inspiratory capacity.
  - FRC to TLC
- Used most effectively to prevent post- operative atelectasis
- Should be used in place of IPPB for atelectasis if the patient has a VC of > 10-15 mL/kg of body weight.
- **If the patient's VC is < 10 mL/kg consider IPPB.**

Hyperventilation Due to Hypoxemia

pH 7.47

$PaCO_2$ 33 torr

PaO_2 58 torr

HCO_3 24 mEq/L

BE -1 mEq/L

- **If patient is on 60% oxygen or higher, institute CPAP.**
- **Note: An exception to this rule is if the patient is hypotensive or has a low cardiac output. In that case, increase the oxygen.**

Air/Oxygen Entrainment Ratios

24%	**25:1**
28%	**10:1**
30%	**8:1**
35%	**5:1**
40%	**3:1**
50%	**1.7:1**
60%	**1:1**

Calculating Air/O2 Ratio

$$\frac{100 - X}{X - 21\ (20^*)}$$

Example: Calculate the air/O_2 ratio for 30%.

$$\frac{100 - 30}{30 - 21} = \frac{70}{9} = 7.7 = 8{:}1$$

- *Use 20 if calculating ratio for 40% or higher

Calculating Total Flow

- Add the two ratio parts together and multiply by the flow.
- Example (from exam): A 60% aerosol mask is running at 8 L/min. What is the total flow from the device?

  60% (1:1 ratio)
  2 x 8 = 16 L/min

- Total flow must be at least *25-30 L/min* to meet the patient's normal inspiratory flow demands

HME vs Heated Humidifier

- HME provides 70-90% body humidity
- Avoid using HME when thick, tenacious secretions are present
- Heated humidifier provides 100% body humidity

Methods to Correct Inverse I:E Ratio

- Increase inspiratory flow** (shortens insp. time)
- Decrease tidal volume (shortens insp. time)
- Decrease respiratory rate (lengthens exp. time)
- Maintain I:E ratio at 1:2 or 1:3

** Most appropriate ventilator change

Calculating Cylinder Duration Time

minutes remaining in cylinder =

$$\frac{\text{cylinder pressure x cylinder factor}}{\text{liter flow}}$$

- E cylinder factor = .28 L/psi (.3)
- H cylinder factor = 3.14 L/psi (3)

Calculating Cylinder Duration Time

$$\frac{1500 \times 3.14}{5} = \frac{4710}{5} = 942 \text{ minutes}$$

$$\frac{942}{60} = 15.7 \text{ hrs}$$

Heliox Therapy

- Because the gas mixture is a low density, lightweight gas it gets through obstructions easier.
- Should be delivered through a tight-fitting NRB
- Most common mixtures are 80/20 and 70/30.
- Commonly used on asthmatics or patients with airway obstructions

Flowmeter Reading Corrections Using Heliox

- Factors when running heliox mixtures through an oxygen flowmeter:
  - 80/20 – 1.8
  - 70/30 – 1.6
- In other words, 1.8 times more 80/20 heliox mixture is running through an O_2 flowmeter than the flowmeter is indicating.
- Example: An 80/20 heliox mixture is running through an O_2 flowmeter at 10 L/min. What flow is the patient receiving?
  - 10 x 1.8 = 18 L/min.

Flowmeter Reading Corrections Using Heliox

- When determining what flowrate to use to deliver a specific flow of heliox, divide by the factor.
- Example (from exam): $\frac{12 \text{ L/min}}{1.6} = 7.5$ L/min
- In other words, in order to deliver the prescribed 12 L/min of the 70/30 heliox mixture through an oxygen flowmeter, the flowrate needs to be set at 7.5 L/min.

End-tidal CO_2 Detector

- Used to confirm ET tube is in the airway
- 5%-6% CO_2 in exhaled air
- Must confirm tube placement with auscultation and CXR

Positive Expiratory Pressure (PEP)

- Achieved by patient exhaling through mouthpiece or mask through a resistance valve.
- 10-20 cm H_2O of PEP is commonly used
- It is becoming increasing popular as an alternative to CPT in cystic fibrosis patients.
- Also effective in preventing post-op atelectasis

PEP Device

II. Troubleshooting and Quality Control of Equipment, and Infection Control (20 questions)

B. Infection Control (2 questions)
C. Perform Quality Control Procedures (3 questions)

Acetic Acid (Vinegar)

- Most common disinfectant used in the home
- Very effective against *pseudomonas*

Calibrating a TcPaO2 Monitor

- Partial pressure = (PB - 47) x fractional concentration

(747 - 47) x .21 =

700 x .21 = 147 torr

Shortcut equation: 7 x 21 = 147 torr

Sterilization Techniques for Respiratory Care Equipment

- Autoclave
- Ethylene Oxide
- Glutaraldehydes (Cidex)

Autoclave

- Sterilizes equipment
- Normal operating levels:
- 15 psig (2 atmospheres) and 121°C for 15 min
- Ventilator bacteria filters are most commonly autoclaved

Ethylene Oxide Gas Sterilization

- Warm gas - 50-56°C for 4 hours
- Cold gas - 22°C for 6-12 hours
- Aeration cycle of 12 hours at 60-70°C
- Equipment must be completely dry before processing to prevent formation of ethylene glycol

Glutaraldehyde

- Cidex is a commonly used glutaraldehyde.
- Disinfects in 10-15 minutes and sterilizes in 3-10 hours
- After removal from solution, the equipment should be rinsed off and dried completely before packaging.

III. Initiation & Modification of Interventions (65 questions)

A. Maintain a Patent Airway Including the Care of Artificial Airways (9 questions)

Dry Powder Inhalers (DPIs)

- Inhalers that deliver drugs in a powder form.
- No propellants or external power sources are used.
- The patient must be able to generate an inspiratory flow of at least 50 L/min for the device to aerosolize the dry powder effectively, which may be difficult to achieve when a patient is in respiratory distress, such as an asthma attack.
- Can't be used with infants and small children due to high flow limitations.
- Salmeterol (Serevent) and tiotropium (Spiriva) are examples of bronchodilators delivered by DPI

Respiratory Distress

- On the exam, look for adjectives such as mild, moderate or severe (marked)
- The more severe the respiratory distress, the more aggressive the action

Treatment for Post-Extubation Glottic Edema

- **Racemic epinephrine via SVN**
- **Corticosteroid (IV or MDI)**

- **Major clinical sign of post-extubation glottic edema is inspiratory stridor**

- **Failure to reverse the swelling may result in reintubation.**

ET Tube Cuff Pressure

- Appropriate range to prevent mucosal damage and provide for an adequate seal:

➢ 20-30 cm H_2O

III. Initiation & Modification of Interventions (65 questions)

B. Perform Airway Clearance and Lung Expansion Techniques (6 questions)
C. Support Oxygenation and Ventilation (9 questions)

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Ventilator Management

- Correcting Hypercapnia
  - Increase V_T
  - Increase respiratory rate
- **Note: Increasing the ventilator rate when in AC mode will not be beneficial if the patient is triggering above the set rate**

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Normal Neonatal ABG Values

pH	7.35-7.45
$PaCO_2$	35-45 torr
PaO_2	50-70 torr
HCO_3	20-22 mEq/L
BE	-2 to -6 mEq/L

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Pressure-Control Ventilation

- To increase minute volume to reduce $PaCO_2$:

  - Increase PIP
  - Increase rate

Initial Ventilator Settings

- Mode - AC or SIMV
- VT – 6-8 mL/kg IBW
- Rate - 10-16/min
- F_IO_2 - percent patient was on prior to ventilation
- Flow - 40-60 L/min

Noninvasive Positive Pressure Ventilation (NPPV)

- **To decrease the $PaCO_2$, increase the IPAP.**
- **To increase the $PaCO_2$, decrease the IPAP.**
- **To increase the PaO_2, increase the F_IO_2 or EPAP.**
- **To decrease the PaO_2, decrease the F_IO_2 or EPAP.**

Determining Proper Suction Catheter Size

- Multiply the ET tube size by 2 and use the next smallest catheter size.
- Example: What is the proper size suction catheter for suctioning a 6.0 ET tube?
- 6 x 2 = 12
- Use a 10 Fr. catheter
- Catheter sizes in Fr. are 6.5, 8, 10, 12, 14,16

ET Tube Suctioning Levels

- Adults: -100 to -120 mm Hg (< -150)
- Children: -80 to -100 mm Hg (-120 max)
- Infants: -60 to -80 mmHg (-100 max)

Ventilator Management

- Correcting hyperventilation with hypoxemia:
  - Increase PEEP if on 60% O_2 or higher
  - Increase O_2 % if on less than 60% (on exam don't exceed 60%)
- Correcting hyperventilation without hypoxemia:
  - Decrease tidal volume or ventilator rate

Correcting Hyperoxemia

pH 7.41
$PaCO_2$ 42 torr
PaO_2 157 torr
HCO_3 22 mEq/L
BE -2 mEq/L

- If on more than 60% O_2, decrease the O_2.
- If on less than 60% O_2, decrease the PEEP*.

***Exception: Patient with ARDS or pulmonary edema (PEEP beneficial**)

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Ventilation of ARDS Patients

- Use PC to avoid high airway pressures
- Maintain plateau pressure at 30 cm H_2O or less
- Permissive hypercapnia acceptable on exam
- Use V_T of 4-6 mL/kg

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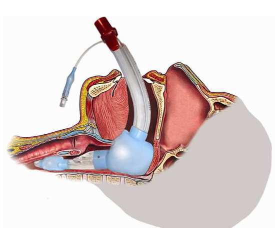
King Airway

- For emergency airway management
- Blind insertion – distal tip resides in esophagus
- Must confirm proper placement



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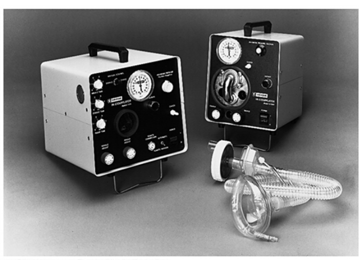
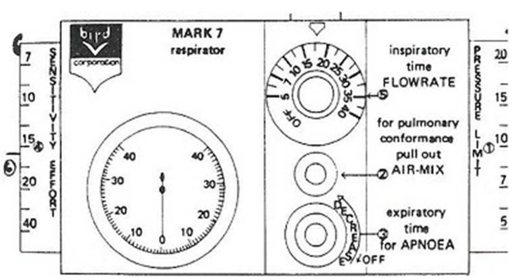
Mechanical Insufflation-Exsufflation

- Assists or replaces cough clearance for patients with respiratory muscle weakness or paralysis
- Device generates inspiratory positive pressures of 30-50 cm H_2O for 1-3 sec
- Pressures reversed to -10 to -50 cm H_2O during exhalation
- Rapid change in pressure results in stronger, more effective cough

Mechanical Insufflation-Exsufflation



IPPB Machine



NPPV

- When using PC or NPPV always note the patient's exhaled V_T.
- Set PIP or IPAP level to maintain a V_T of 6-8 mL/kg.

Pressure-Cycled IPPB Units

- Inspiration ends when preset pressure is delivered.
- If airway resistance increases or lung compliance decreases, tidal volume and inspiratory time decreases.

IPPB Self-Triggering

- Decrease sensitivity (-1 to -2 cm H_2O proper setting)
- Make sure rate control (expiratory timer) is turned off)

Neonatal Ventilation

pH 7.29
$PaCO_2$ 53 torr
PaO_2 46 torr
HCO_3 27 mEq/L
BE +2 mEq/L

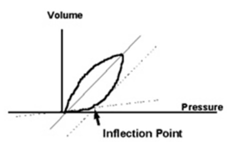
Increase PIP to lower $PaCO_2$

Indications for Ventilator Weaning

- MIP of at least -20 cm H_2O
- VC > 10-15 mL/kg
- Spontaneous V_T at least 5-6 mL/kg (IBW)
- RSBI (rate/V_T) < 105
- VD/VT < 0.60
- $P(A-a)O_2$ < 350 mm Hg on 100% oxygen
- PaO_2/F_IO_2 > 200
- PEEP < 10 cm H_2O

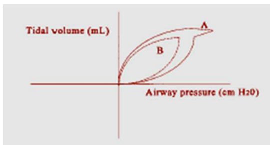
Assessing for Optimal PEEP

- Lower inflection point on P/V loop indicates the point of alveolar recruitment and optimal PEEP setting



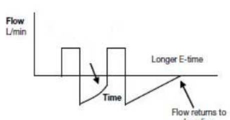
Assessing for Over-distention

- Over-distention is assessed by looking for "bird-beak" on the pressure/volume loop
- Tidal volume should be decreased to minimize the chances of barotrauma



Assessing for Air-Trapping

- When expiratory flow does not return to baseline, expiratory time must be lengthened



III. Initiation & Modification of Interventions (65 questions)

D. Administer Medications and Specialty Gases (5 questions)
E. Ensure Modifications are Made to the Respiratory Care Plan (19 questions)

Calculating Static Lung Compliance

$$\text{Static } C_L = \frac{\text{tidal volume}}{\text{plateau - PEEP}}$$

$$\text{Static } C_L = \frac{500}{20-5} = \frac{500}{15} = 33 \text{ mL/cm } H_2O$$

- **Note: Always use the exhaled tidal volume rather than the ventilator tidal volume for more accuracy.**

IPPB vs Incentive Spirometry

- **IPPB is not indicated to help prevent postoperative atelectasis if the patient can obtain a vital capacity of *> 10-15 mL/kg* of ideal body weight.**
- **In this question, the patient has a VC of 2.2L. Regardless of the patient's weight, which isn't given, this represents a VC of greater than 10-15 mL/kg of body weight.**

Calculating Desired Tidal Volume

$$\text{Desired } V_T = \frac{V_T \text{ (current)} \times PaCO_2 \text{ (current)}}{PaCO_2 \text{ (desired)}}$$

$$\text{Desired } V_T = \frac{0.7 \text{ L} \times 30}{35} = 0.6 \text{ L}$$

Choice C: 600 mL

Calculating Total Flow

Calculate the air/O_2 ratio for 35%.

$$\frac{100 - 35}{35 - 21} = \frac{65}{14} = 4.6 = 5:1$$

Liter flow is 6 L/min

Add ratio parts together (5+1=6) and multiply by the flow: 6 x 6 = 36 L/min

Oxygenation of the COPD Patient

- **To determine if the oxygen level is excessive on a chronically hypoxemic COPD patient, resulting in a decreased respiratory drive, look at the PaO_2.**
- **If the PaO_2 is in the 70s or higher, the likelihood of reducing the patient's ventilatory drive increases.**
- **In this question, the PaO_2 is only 53 torr, therefore the ventilatory drive will not be reduced.**

Mechanical Deadspace

- Deadspace is added between the patient's ET tube and ventilator circuit so that the hypocapnic patient will rebreathe CO_2.
- For every 100 mL (1 foot) of tubing added, the $PaCO_2$ increases approximately 5 torr.
- Deadspace should NEVER be added if the patient is in a spontaneous breathing mode (SIMV, CPAP).
- If the patient is hypercapnic, ALWAYS remove the deadspace first.

Heliox Flow Correction

- 80/20 heliox flow factor – 1.8
- Multiply factor times the flowmeter reading
- 1.8 x 15 = 27 L/min

High-Flow Nasal Cannula

- Flowrates of up to 60 L/min
- Delivered O_2 levels up to 100%
- High flow washes out CO2 in anatomic deadspace
- May provide CPAP for alveolar recruitment

Refractory Hypoxemia

- Hypoxemia not responsive to increasing oxygen percentages
- Increase the inspiratory time (decreased flowrate) which increases MAP to increase the PaO_2

Ventilator Flowrate

- Flowrate should be a minimum of 40-60 L/min
- Inadequate flowrate (20 L/min) lengthens the inspiratory time which can cause patient agitation

Calculating IBW to Determine Ventilator Settings

Males: 106+6 (height in inches - 60)

Females: 105+5 (height in inches - 60)

- Example in question: 106 + 6 (65 - 60)
  106 + 30 = 136 lb.
  136/2.2 = 62 kg

III. Initiation & Modification of Interventions (65 questions)

F. Utilize Evidence-Based Medicine Principles (6 questions)
G. Provide Respiratory Care in High-Risk Situations (4 questions)
H. Assist a Physician/Provider in Performing Procedures (4 questions)
I. Initiate and Conduct Patient and Family Education (3 questions)

Calculating Liquid O2 Duration Time

- (1 liter of liquid oxygen weighs 2.5 lb)
- Gas remaining = $\frac{\text{liquid weight (lb)} \times 860}{2.5 \text{ lb/L}}$
- ** Shortcut equation: 344 x lb weight**
- Gas remaining = $\frac{1376 \text{ L}}{2 \text{ L/min}}$ = 688 min (11.5 hrs)

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Fiberoptic Bronchoscopy

To stop bleeding during a bronchoscopy instill one of following:

- epinephrine
- racemic epinephrine
- cold saline

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Cardioversion

- Use 120-200 joules
- Helps convert atrial fib and atrial flutter
- Have emergency equipment at bedside during the procedure

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Drugs Used During Bronchoscopy

- Atropine – dries out airway, reduces effects of vagal stimulation (bradycardia)
- Lidocaine – numbs the airway
- Versed – provides conscious sedation

Tracheal Shift

- Trachea shifts *away* from tension pneumothorax
- Trachea shifts *toward* atelectasis, consolidation
- In this question, because of the high respiratory rate and moderate to severe hypoxemia, needle aspiration is indicated

NAEPP Asthma Severity

Components of Severity		Classification of Asthma Severity (Youths ≥12 years of age and adults)			
			Persistent		
		Intermittent	Mild	Moderate	Severe
Impairment Normal FEV_1/FVC: 8-19 yr 85% 20-39 yr 80% 40-59 yr 75% 60-80 yr 70%	Symptoms	≤2 days/week	>2 days/week but not daily	Daily	Throughout the day
	Nighttime awakenings	≤2x/month	3-4x/month	>1x/week but not nightly	Often 7x/week
	Short-acting $beta_2$-agonist use for symptom control (not prevention of EIB)	≤2 days/week	>2 days/week but not >1x/day	Daily	Several times per day
	Interference with normal activity	None	Minor limitation	Some limitation	Extremely limited
	Lung function	• Normal FEV_1 between exacerbations • FEV_1 ≥80% predicted • FEV_1/FVC normal	• FEV_1 ≥80% predicted • FEV_1/FVC normal	• FEV_1 >60% but <80% predicted • FEV_1/FVC reduced 5%	• FEV_1 <60% predicted • FEV_1/FVC reduced >5%
Risk	Exacerbations requiring oral systemic corticosteroids	0-1/year	≥2/year →		
		← Consider severity and interval since last exacerbation. Frequency and severity may fluctuate over time for patients in any severity category. →			
		Relative annual risk of exacerbations may be related to FEV_1			

Inadequate Volumes with Manual Resuscitator

- Leak around ET tube or tracheostomy tube cuff
- Leak through the exhalation valve
- Leak through the oxygen inlet valve

Equipment Prep for Bronchoscopy

- PPE (Mask, gloves, gown)
- Bronchoscope
- Light source
- Brushes and forceps
- Syringes
- Normal saline
- Collection devices
- Sterile gauze
- Intubation equipment
- Pulse ox
- ECG and BP
- Suction and supplies
- Appropriate medications

Troubleshooting Chest Tubes

- Excessive bubbling in water seal
  - Leak in patient or system
- Excessive bubbling in suction control bottle
  - Suction pressure set too high