

Module 1 - Distribution and Administration of Medical and Anesthetic Gases

This module will give the learner of medical and anesthetic gas administration. This will include all gasses, their equipment, indications for use and formulas.

Rationale

Why is it important for you to learn this material?

Medical gas delivery can be originated from a variety of sources. When using cylinders, filling pressures may be as high as 2200 psi. An understanding of their usage and safety features is therefore essential.

A large portion of the Respiratory Therapist's daily activities involves using equipment that requires medical oxygen and air sources. Understanding the various supply systems is therefore essential in order to provide safe care for the patient and to allow flexible delivery options for the Respiratory Therapist.

Oxygen therapy systems can be differentiated into low- and high-flow systems. It is imperative that a caregiver understands not only when a patient requires oxygen therapy, as discussed in the previous module, but also what type of delivery system should be used.

As Respiratory Therapists working in the operating room, we may be required to assist the anaesthetist in administering the anaesthetic as well as assisting with the various procedures required to anaesthetise the patient. Therefore, it is imperative that the operating room respiratory therapists understand the different types of procedures, techniques, and types of anaesthesia used, and the effects of these.

Learning Outcome

When you complete this module you will be able to

Describe the usage and safety features related to a medical gas cylinder, administer oxygen in the most safe and efficient manner, and familiarize yourself with important considerations around the use of various types of anaesthesia.

Learning Objectives

Here is what you will be able to do when you complete each objective.

- Describe medical gas cylinders in terms of tank and liquid duration, gas flow, and Canadian standards.
- Describe low- and high-flow devices and their comparisons.
- Discuss the indications and hazards of oxygen therapy.
- Describe patient considerations when preparing for anaesthesia.
- Describe alveolar effects of anaesthetic agents.
- Describe induction procedures in terms of the type of anaesthesia.

Objective 1

When you complete this objective you will be able to...

Describe medical gas cylinders in terms of tank and liquid duration, gas flow, and Canadian standards

Learning Activity

Complete each of the Learning Activities listed below.

Objective Content – Read pages 31 - 44 from Cairo, J.M., Mosby's Respiratory Care Equipment, 7th Edition.

Answer the following questions.

1. What is the colour code and purity for the following gases?
 - a. Air
 - b. carbon dioxide
 - c. cyclopropane
 - d. ethylene
 - e. helium
 - f. helium/oxygen
 - g. nitrogen
 - h. nitrous oxide
 - i. oxygen
2. Identify what each tank shoulder marking means.
3. What two types of valves are found on cylinders? Which cylinders would use which type of valves? What are the advantages of each?
4. Describe the type of pressure-relief systems found on cylinder valves.
5. List the various safety regulations for gas cylinders.

Answer the following questions.

1. What are the cylinder factors for a D, E, or H size cylinder? How are these cylinder factors determined?
2. Given a full E size cylinder, how long would it last at a flow of 3 L/min?
3. How many D size cylinders would be required for a 10-hour transport? The patient will require 15 L/min of oxygen?
4. When calculating cylinder durations, should you round your final answer up or down? Why?
5. How would you calculate the duration of a cylinder whose contents are liquid?

Objective 2

When you complete this objective you will be able to...

Describe low- and high-flow devices and their comparisons.

Learning Activity

Complete each of the Learning Activities listed below.

Objective Content – Read pages 49 - 50, 64 - 75 from Cairo, J.M., Mosby's Respiratory Care Equipment, 7th Edition. Also read pages 833 - 841 from Wilkins, Stoller, and Scanlan, Egan's Fundamentals of Respiratory Care, 8th Edition.

Answer the following questions.

1. Describe the principle of operation for:
 - Semipermeable membrane concentrators
 - Molecular sieve bed concentrators
2. How does flowrate affect the delivered oxygen concentration for the above two types of concentrators?
3. When using an oxygen concentrator of either type:
 - How would you verify the oxygen concentration the unit is delivering?
 - What maintenance would be required by the patient?
 - What maintenance would be required by the Respiratory Therapist?
 - Describe the various considerations when using an oxygen concentrator in the home environment.
4. What advantage does a nasal cannula have over a simple mask?
5. What advantages does a transtracheal catheter have over a nasal cannula?
6. For each of the following low-flow devices, match the associated oxygen flow and FiO₂

Nasal Catheter	.35 - .60
	Flow to keep reservoir bag 2/3's full
Nasal Cannula	.22 - .45
	1/4 – 8 L/min
Simple Mask	.60 - .80
	Flow to keep reservoir bag 2/3's full
Partial Rebreathing Mask	.35 - .50

5 - 12 L/min

Non Rebreathing Mask .55 - .70

1/4 – 8 L/min

Answer the following questions.

1. What range of oxygen concentrations can a high-flow device deliver?
2. If a high-flow entrainment device is powered by air, what concentration of oxygen will it deliver independent of FiO₂ setting?
3. What is the principle of operation for air entrainment devices?
4. What differentiates a low-flow from a high-flow system?

Answer the following questions.

1. Complete the following chart for the spontaneously breathing patient:

RR	Vt (mls)	I:E	Insp. Flow (lpm)	Ti (sec)
10	500	1:2		
15	600	1:3		
12		1:1		

2. Oxygen flow into an air entrainment mask is set at 4 L/min. Calculate the total flow out of the unit if the jet was set at:
 - a. 24%
 - b. 28%
 - c. 35%
 - d. 40%
 - e. 60%
3. What would happen to FiO₂ and total flow out of an air entrainment device if the following changes were made?
 - a. decrease jet size
 - b. decrease entrainment port size
 - c. increase oxygen flow
 - d. increase jet size
 - e. increase entrainment port size
 - f. increase back pressure
4. What is the ventilatory criteria for low-flow oxygen usage?

5. If a patient were receiving low-flow oxygen therapy via nasal cannula, how does an increase in minute ventilation affect delivered FiO_2 ? Why?

Objective 3

When you complete this objective you will be able to...

Discuss indications and hazards of oxygen therapy.

Learning Activity

Complete each of the Learning Activities listed below.

Objective Content – Read pages 531 - 534, 827 - 830 from Wilkins, Stoller, and Scanlan, Egan's Fundamentals of Respiratory Care, 8th Edition.

Answer the following questions.

1. Define hypoxemia.
2. List the physiological causes of hypoxemia.
3. Describe the pulmonary and cardiovascular responses to hypoxemia.
 - Describe pulmonary hypertension.
 - How does the myocardium function in the presence of hypoxemia?
4. Which of the following are clinical signs of hypoxemia?
 - Cyanosis
 - restlessness, disorientation, lethargy, and coma
 - tachypnea
 - dyspnea
 - tachycardia or bradycardia
 - dysrhythmias
 - hypertension or hypotension
 - polycythemia
 - clubbing
5. Differentiate hypoxia from hypoxemia.
6. Describe the four types of hypoxia. Which are responsive to oxygen therapy?

Answer the following questions.

1. What are oxygen free radicals? What damage do they do?
2. Describe the physiological cycle created by managing hypoxemia with high FiO_2 's.
3. As a result of oxygen toxicity, several pathological pathways can occur in various patient populations. Describe the complications of each of the following:
 - Depression of ventilation/induced hypoventilation
 - Absorption atelectasis
 - Retinopathy of prematurity

4. Oxygen supports combustion. Discuss issues in the hospital setting and in the home that must be presented to the patient in order to maintain safe use of oxygen.

Objective 4

When you complete this objective you will be able to...

Describe patient considerations when preparing for anaesthesia:

- airway
- pre-operative assessment
- IV considerations
- Positioning
- monitoring

Learning Activity

Complete each of the Learning Activities listed below.

Objective Content – Read pages 153 - 161 from Chung, D.C. and Lam, A.M., Essentials of Anaesthesiology, 3rd Edition.

Answer the following questions.

1. Briefly describe the classification of a patient's physical status as recommended by the American Society of Anaesthesiologists.
2. Identify all major components of the preoperative assessment and describe them.

Objective 5

When you complete this objective you will be able to...

Describe the alveolar effects of anaesthetic agents:

- diffusion hypoxia
- minimum alveolar concentration
- second gas effect

Learning Activity

Complete each of the Learning Activities listed below.

Objective Content – Read pages 28 - 37 from Chung D.C. and. Lam A.M., Essentials of Anaesthesiology, 3rd Edition.

Answer the following questions.

1. Describe what the second gas effect is.
2. Explain the significance of MAC.
3. How can diffusion hypoxia occur?

Objective 6

When you complete this objective you will be able to...

Describe induction procedures in terms of the type of anesthesia.

- general
- regional
- dissociative
- local
- neuroleptanalgesia

Learning Activity

Complete each of the Learning Activities listed below.

Objective Content – Read pages 214 - 222, 237 - 250, Chung, D.C. and Lam, A.M., Essentials of Anaesthesiology, 3rd Edition.

Answer the following questions.

1. Match the following types of anaesthetics from the selections below.

Local_____

General_____

Regional_____

Neurolept_____

Dissociative_____

- This anaesthetic drug produces an altered type of mental state that can be characterised by amnesia, analgesia, catalepsy, and sedation. It is not used very frequently.
- Anaesthesia that is targeted to an area of the body by the injection of a local anaesthetic to block specific sensory nerve-fibre groups. I.e. epidural anaesthesia.
- This type of anaesthesia is attained via an administration of a butyrophenone with a narcotic analgesic.
- This type of anaesthesia is based upon a state of reversible loss of awareness and reflex reaction to stimuli by the ability to provide to the patient sufficient analgesia and amnesia during a surgical procedure.
- A clinically useful anaesthetic drug that blocks impulse conduction in the nerve fibres.

2. Describe the risks of anaesthesia to patients regarding:
 - Pregnancy
 - Age
 - Weight
 - Substance abuse
3. Briefly summarize the concept of rapid sequence induction.