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A Comprehensive Manual of Pediatric Nursing Procedures



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Foreword
Asha P Shetty

3rd Edition

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Contents

1. Newborn Care 1
- ♦ Neonatal Resuscitation 2
- ♦ Newborn Assessment 9
- ♦ Newborn History Taking 21
- ♦ Baby Bath 22
- ♦ Kangaroo Mother Care 26
- ♦ Radiant Warmer 28
- ♦ Phototherapy 31
- ♦ Incubator 34
- ♦ Apnea Monitor 36
- ♦ Oro-Pharyngeal Suctioning in Newborn 38
- ♦ Nesting 38

2. Assessment Procedures 41
- ♦ Admission Procedure 42
- ♦ History Taking 43
- ♦ Vital Signs 50
- ♦ Assessment of Pain in Pediatric Clients 58
- ♦ Anthropometric Measurements 63
- ♦ Abdominal Girth 70
- ♦ Physical Examination 71
- ♦ Assessment of Dehydration in Children 85
- ♦ Developmental Assessment 88
- ♦ Neurological Examination 93
- ♦ Documentation 99

3. Assisting in Diagnostic Procedures 103
- ♦ Collection of Blood Sample (Venipuncture) 104
- ♦ Arterial Puncture and Blood Gas Analysis 106
- ♦ Capillary Blood Sampling 110
- ♦ Urine Specimen Collection 112
- ♦ Stool Specimen Collection 114
- ♦ Lumbar Puncture 116
- ♦ Liver Biopsy 119
- ♦ Kidney Biopsy 120
- ♦ Bone Marrow Aspiration 122
- ♦ Cardiac Catheterization 124
- ♦ Electrocardiogram 127
- ♦ Fine Needle Aspiration 131

4. Meeting Nutritional Needs 134
- ♦ Assisting in Breast Feeding 134
- ♦ Cleaning and Sterilization of Feeding Articles 140
- ♦ Formula Feeding 141

- Gavage Feeding 142
- Gastrostomy Feeding 145
- Jejunostomy Feeding (Postpyloric or Transpyloric Feeding) 148
- Total Parenteral Nutrition 150

5. Respiratory Care 155
- Surfactant Therapy 155
- Steam Inhalation 158
- Nebulization 159
- Oxygen Therapy 162
- Chest Physiotherapy 168
- Incentive Spirometry 172

6. Administration of Medications and Vaccines 174
- Introduction to Administration of Medications in Children 175
- Oral Medications 176
- Intramuscular Injection 180
- Intradermal Injection 182
- Subcutaneous Administration of Medications 183
- Intravenous Therapy 184
- Instillation 190
- Topical Applications 193
- Administration of Vaccines 194

7. Elimination Needs 198
- Urinary Catheterization 199
- Suprapubic Catheterization 205
- Enema 208
- Colostomy Care 210
- Colonic Irrigation 212
- Double Diapering 213
- Ureterostomy Care 213
- Insertion of Suppository 215
- Enterostomy Care 216

8. Emergency Procedures 218
- Manual Removal of Foreign Body from the Airway 219
- Cardiopulmonary Resuscitation 220
- Tracheostomy Care 226
- Care of a Child on Mechanical Ventilation 230
- Pulse Oximetry 236
- Abdominal Paracentesis 239
- Blood Transfusion 240
- Exchange Blood Transfusion 245
- Gastric Lavage 249
- Umbilical Vein Catheterization 251
- Thoracentesis 252

9. Safety and Recreation 255
- ♦ Play Therapy 255
- ♦ Restraints 259

10. Care of Child With Fracture 266
- ♦ Traction Care 266
- ♦ Cast Care 270

11. Care of Child Undergoing Surgery 276
- ♦ Pre and Postoperative Nursing Care 276
- ♦ Surgical Dressing 281
- ♦ Removal of Sutures 283
- ♦ Dressing for Open Neural Tube Defects 284

12. Meeting Children's Hygienic Needs 287
- ♦ Introduction to Hygienic Needs 287
- ♦ Oral Hygiene 288
- ♦ Eye Care 289
- ♦ Ear Care 289
- ♦ Bathing 290

13. Recent Advances in Prenatal, Neonatal, and Pediatric Care 293
- ♦ Laminar Flow Hoods 293
- ♦ Noninvasive Fetal Electrocardiography Monitoring 294
- ♦ Transcutaneous Bilimeter 296
- ♦ Giraffe Incubator 297
- ♦ Bubble CPAP 298
- ♦ Body Cooling 302
- ♦ Flux Meter 305
- ♦ Oxygen Analyzer 305
- ♦ High Flow Nasal Cannula 306

Annexure 311
Index 333

5 CHAPTER

Respiratory Care

Chapter Outline

- Surfactant Therapy
- Steam Inhalation
- Nebulization
- Oxygen Therapy
- Chest Physiotherapy
- Incentive Spirometry

Learning Objectives

Upon the completion of this chapter, the learners will be able to:

- Explain the different methods of oxygen administration.
- Perform postural drainage.
- Demonstrate respiratory care procedures.

Keywords: Respiratory tract, surfactant, oxygen, inhalation, pulmonary function, air.

SURFACTANT THERAPY

Definition

Surfactant therapy is the medical administration of exogenous surfactant typically instilled directly into the trachea.

Indications

- **Surfactant deficiency:** Respiratory distress syndrome (RDS)
- **Surfactant inactivation:** Meconium aspiration syndrome

Contraindications for SRT

- Congenital anomalies incompatible with life
- Perfusion failure states
- Diffuse pulmonary hemorrhage conditions
- Diagnosis of congenital diaphragmatic hernia

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Purposes

- To improve survival of newborns
- To reduce respiratory morbidities

Strategies of Surfactant Treatment (SRT)

- **Prophylactic surfactant therapy:** Refers to a strategy of providing exogenous surfactant at birth to infants at risk for RDS, with the aim of preventing severe RDS from developing.
- **Selective surfactant therapy:** Refers to a strategy of providing exogenous surfactant to infants with established RDS.

Types of Surfactants

- **Animal-derived or natural surfactant:** Bovine and porcine extracts
- New generation synthetic surfactants

Techniques of Administration

- **Conventional methods:**
  - ✦ **INSURE:** Intubate, Surfactant, Extubate
  - ✦ CPAP
- **Newer techniques:**
  - ✦ Less invasive surfactant administration (LISA): Placing a small, thin catheter in the trachea with Magill forceps under direct laryngoscopy while the infant continues on CPAP support
  - ✦ Laryngeal mask airway
  - ✦ Pharyngeal surfactant administration
  - ✦ Nebulization-true noninvasive method of surfactant administration
  - ✦ Bubble CPAP

Modes of Delivering Surfactant

- **Rapid bolus administration:** Recommended mode of administration:
  - ✦ One dose: Complete dose given within a single time frame.
  - ✦ Multiple doses: Total dose divided into two or more amounts (aliquots) and given separately in time.
- Continuous infusion (slow administration of surfactant preparation)

Adverse Effects

- Bradycardia
- Hypotension
- Oxygen desaturation

Side Effects

- Pneumothorax
- Pulmonary hemorrhage
- Intraventricular hemorrhage
- Patent ductus arteriosus
- Retinopathy
- Necrotizing enterocolitis
- Immune reaction
- Sepsis
- Risk for injury to airway

Criteria for SRT

- **<24 weeks of gestational age:** These infants should be intubated immediately after birth and surfactant given prophylactically (within the first 15 min to 30 min of life).
- **≥ 24 weeks of gestational age:**
  - ✦ *For infant's intubated immediately after birth:* Surfactant be given as early treatment (2 h of age), except if the infant is on room air and minimal ventilator support on NICU admission.
  - ✦ Infants initially treated with noninvasive ventilation, endotracheal intubation and surfactant administration is recommended in the following conditions:
  - ✦ Fraction of inspired oxygen (FiO_2) >0.5 to maintain saturation (SpO_2) >88% or a partial pressure of arterial oxygen (PaO_2) >45 mm Hg.
  - ✦ Partial pressure of arterial carbon dioxide ($PaCO_2$) >55 mm Hg to 60 mm Hg with a pH <7.25.
  - ✦ Apnea requiring bag and mask ventilation.
  - ✦ >6 apneas/6 hour.
  - ✦ Evidence of significant work of breathing (retractions, grunting, and chest wall distortion in infants presenting with increases in oxygen needs.

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Preliminary Assessment for SRT

- **Respiratory assessment:** Respiratory rate, ventilator pressures, tidal volumes, and transcutaneous PCO_2. Assess the chest for air entry, adventitious sounds, symmetry of chest expansion, and presence of secretion.
- **Vital signs:** Assess the heart rate, oxygen saturation, and blood pressure.
- **Infant status:** Awake, asleep, or sedated.
- Chest X-ray review to assess the endotracheal tube (ETT) position and lung volume.

Equipments Needed for SRT

- Surfactant
- **Alcohol swab in a bowl:** To clean the vial cap
- **Luer lock syringe and needle:** To withdraw medication from vial

Team Approach to SRT

- Respiratory therapist (administer surfactant)
- Neonatal nurse
- Critical care specialist
- Pulmonologist

Preprocedure Care

- **Preoxygenation:** The oxygen concentration should be increased to achieve SpO_2 >95% before surfactant delivery.
- Suction the ET tube and listen to the air entry.
- **Lung recruitment maneuver:** Provide 5–10 inflations with pressures 1 cmH_2O to 2 cmH_2O above the previous ventilator settings to facilitate drug distribution into the pulmonary airways.
- Record all vital signs.

Steps in Procedure

- Surfactant should be taken from freezer and warm to room temperature. The vial can be rolled but DO NOT shake it.
- Calculate the amount of surfactant needed.



Fig. 5.1: Surfactant administration through ET tube.

- Clean the rubber cap of the vial with alcohol swab.
- Introduce the needle to vial and fill the luer lock syringe with required amount of surfactant.
- Attach the syringe with luer fitting.
- Prime the interval volume of the catheter with medication.
- Attach trach care mac adaptor to ventilator circuit and endotracheal tube **(Fig. 5.1)**.

Guidelines for Surfactant Administration

- In neonatal care settings where CPAP is routinely used to stabilize preterm infants, and when the rate of antenatal corticosteroid administration has been high, prophylactic surfactant is no longer recommended.
- Noninvasive respiratory support should be provided to preterm infants with RDS from birth. Early surfactant should be provided for newborns with increasing severity of RDS.
- Infants with RDS whose oxygen requirements exceed FiO_2 of 0.5 should receive SRT.
- Intubated infants with RDS should receive exogenous surfactant before interfacility transport.
- Repeated dosing of surfactant should be provided to infants only when there is evidence of ongoing moderate-to-severe RDS.

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- For spontaneously breathing infants on CPAP with RDS, noninvasive methods of surfactant administration, such as LISA are preferable.
- Factors such as clinician experience, optimal dosage, volume, and the types of surfactant available must be considered to optimize delivery method.
- Surfactant replacement for infants with meconium aspiration syndrome or pulmonary hemorrhage may be considered at clinician's discretion.

Intraprocedure Care during SRT

- Surfactant should be delivered through an in-line catheter with the tip located at the midtracheal level.
- Bovine extract surfactant dose should be 5 mL/kg (135 mg phospholipids/kg) divided into one or a maximum two aliquots.
- Surfactant should be given as bolus infusion (10 s to 20 s).
- Infant should be disconnected from the ventilator and bagged with inflating bag or T-piece device at a rate of 60 inflations/min and pressure necessary to push the surfactant effectively into the pulmonary airways.
- Stat the bagging approximately 5 s after initiation of surfactant administration.
- Infant should be kept in the horizontal position during the procedure.
- When using more than one aliquot, a minimum period of 30 s to 60 s between the aliquots should be used if infants remained stable.
- Vital signs and ventilator parameters should be monitored during the delivery process.
- Document the time of surfactant administration, number of aliquots, PIP and PEEP used, vital signs and complications if any.
- The ET tube should not be suctioned for following 2 hours unless signs of significant airways obstruction occur.

Post SRT Care

- Monitor the vital signs every 10 minutes for the first one hour after SRT.
- Monitor and record the ventilator parameters every 15 minutes for the next hour.

Highlights

- Infants with RDS and meconium aspiration syndrome require SRT.
- Exogenous surfactant is available in natural and synthetic forms.
- Surfactant is commonly administered as bolus.
- Various techniques such as ET tube intubation, LISA, and nebulization are used for SRT.
- SRT is a team approach.
- It is essential to monitor the vital signs before, during, and after SRT.
- The common adverse effects include bradycardia, hypotension, and oxygen desaturation.

STEAM INHALATION

Definition

Breathing warm and moist air into the mucous membrane of respiratory tract is called steam inhalation.

Indications

Children with:

- Bronchitis
- Asthma
- Acute bronchiolitis
- Cystic fibrosis
- Croup
- Postoperative period

Purposes

- To relieve the inflammation and congestion of the mucous membrane of the respiratory tract and paranasal sinuses
- To soften thick tenacious mucous and help it expel from the respiratory tract
- To provide moisture and heat and to prevent dryness of mucus membrane of the lungs

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- To aid in the absorption of the oxygen
- To relieve the spastic condition of the larynx and bronchi
- To provide aseptic action on the respiratory tract

Equipment/Supplies Needed

- Boiled water in a vessel with lid
- Blanket
- Kidney basin
- Any solution if prescribed, for example, menthol and tincture benzoin

Preparation

- Explain the procedure to the mother and child as appropriate.
- Ensure safety measures to prevent burns and scalds.
- Assemble all the necessary equipment.

Procedure

- Take boiling water with lid covered.
- Make the child to sit on the mother's lap.
- Cover the mother and the child with the blanket.
- Slowly remove the lid and give it for 10–15 minutes.
- Instruct the mother to hold the child carefully.

Postprocedure Care

- Remove the vessel.
- Wipe the child.
- Give chest physiotherapy and postural drainage if needed.
- Record the procedure.

Highlights

- Breathing warm and moist air into the mucous membrane of respiratory tract is called steam inhalation.
- The most important use of steam inhalation is to relieve the inflammation and congestion of the mucous membrane of the respiratory tract and paranasal sinuses.
- Give proper instruction to the mother to hold the child carefully during the procedure.
- Chest physiotherapy and postural drainage can help to remove secretions after steam inhalation.

NEBULIZATION

Definition

Nebulization is a method of administering a drug in which the drug is dissolved in a solution, vaporized, and the vapor is inhaled.

A nebulizer is an electrically powered machine that turns a liquid medication into a mist so that it can be breathed directly into the lungs through a face mask or mouthpiece.

Purposes

- To dilute the secretion
- To induce a productive cough
- To deposit pharmacologic agents in upper and lower respiratory tract
- To decrease bronchial edema

Indications

- Children with acute respiratory tract infection, for example, asthma and pneumonia
- As a part of bronchial drainage to increase the effectiveness of the procedure

Contraindication

Hypersensitivity.

Complications

- Infections due to contaminated equipment
- Adverse reactions

Drugs Used for Nebulization Therapy

- Bronchodilators (e.g., albuterol, formoterol, levalbuterol, and salmeterol)
- Mucolytic drugs (e.g., N-acetylcysteine, dornase alfa)
- Decongestant drugs

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- Anti-inflammatory drugs (e.g., budesonide, flunisolide, fluticasone, and triamcinolone)

Dosage and Frequency

Usually depends on doctor's prescription. For the salbutamol the dosage is:

- **Up to 3 years:** 0.1 mL Asthalin + 2 mL normal saline, q 6–8 h normal saline 2 mL
- **3–12 years:** 0.5 Asthalin + 2 mL normal saline, q 6–8 h normal saline 2 mL

Equipment Needed

A clean tray containing:

- Nebulizer machine with accessories
- Sputum cup with disinfectant solution to collect if coughed out
- Kidney tray to collect the waste
- Stethoscope to auscultate the breath sounds
- Face towel for wiping the face
- Hand towel to dry the hands
- Medicine as prescribed
- Bowl with sterile swabs to clean the accessories before and after the procedure
- Spirit for disinfection of accessories
- Dropper or disposable syringe to measure and to pour the medicine
- Additional set of face mask, tube, and accessories to meet the emergency
- Watch to note the timing

Parts of Nebulizer

- Compressor **(Fig. 5.2)**:
  - ✦ Lid
  - ✦ Air outlet connector
  - ✦ Power switch
  - ✦ Handle
  - ✦ Air filter
  - ✦ Power cord
  - ✦ Power cord storage access
  - ✦ Air inlet connector
  - ✦ Medication cup
  - ✦ Cap or dome
  - ✦ Baffle
  - ✦ Mouthpiece
  - ✦ Face mask
  - ✦ Tubing
  - ✦ Accessories storage recess

Types of Nebulizers

- **Jet nebulizer:** This uses compressed gas to make an aerosol (tiny particles of medications in the air).
- **Ultrasonic nebulizer:** This makes an aerosol through high-frequency vibrations. The particles are larger than with a jet nebulizer.
- **Vibrating mesh nebulizer:** This kind of nebulizer puts out the smallest particles. It's also the most expensive.

Instructions

- Always keep an extra nebulizer or its accessories in hand. Prior to using the machine, check for its working condition.
- If the treatment is longer than 10–15 minutes, check if the mist output nebulization may be clogged or dirt can obstruct the airflow from the compressor.
- If the treatment is shorter than the normal, check to see if the medicine is leaking out of the nebulizer.
- The nebulizer must not be touched with wet or soaked hands.
- No smoking, no fire around the equipment when in use.
- Do not pour medication solution >10 mL into the medication cup.
- Filter should be changed when it turns completely gray in color.

Nebulization Therapy

Methods

- Mouthpiece treatments for children ages 8 years and older. The child places the mouthpiece between the teeth, using the lips to form a tight seal.
- **Mask treatment (children <8 years):** An aerosol mask is placed on the nebulizer and then secured over the nose and mouth of the child. The mist breathed in through the

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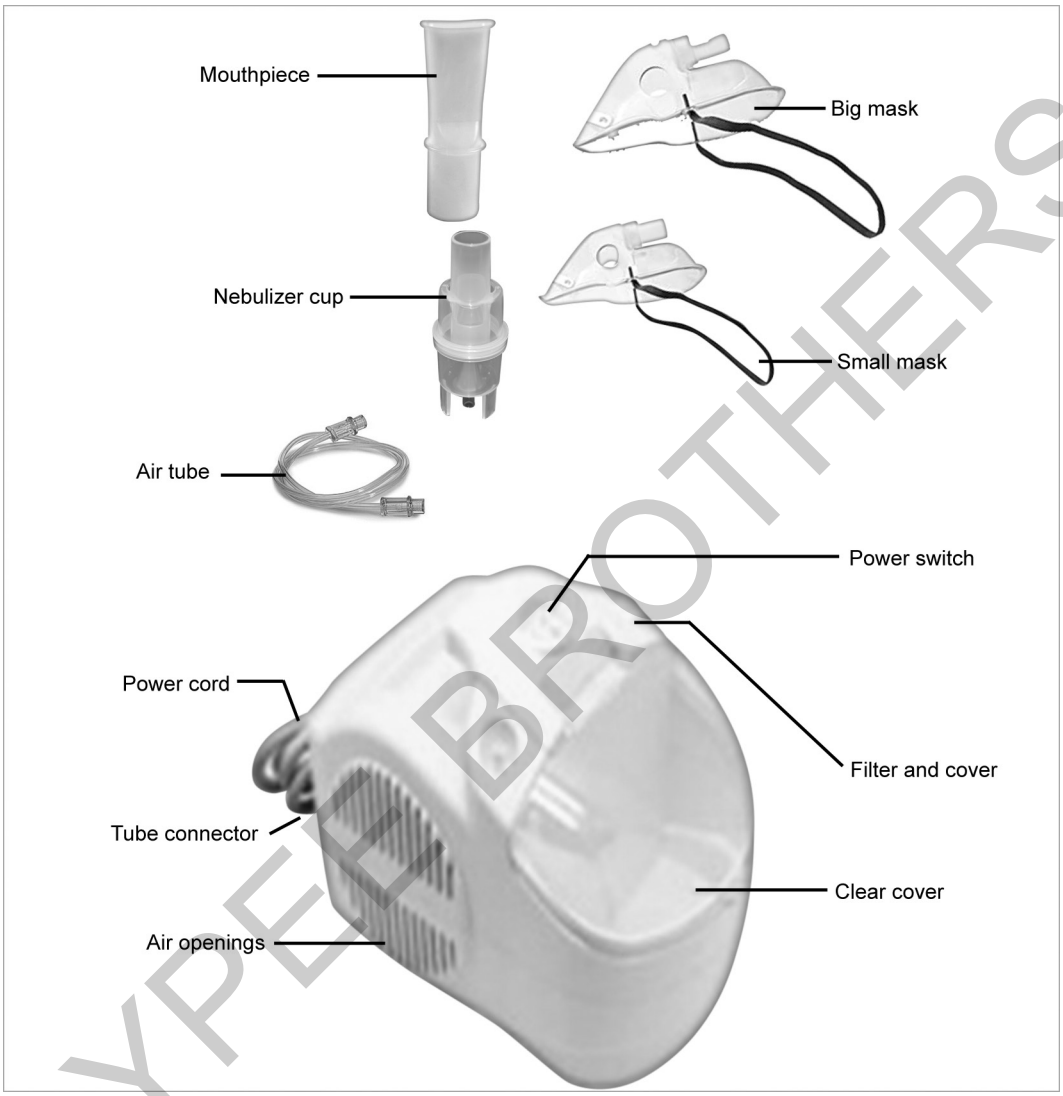

Fig. 5.2: Parts of nebulizer.

child's mouth and nose. Placing the mask on a young child can be scary.

- Blow by treatment (very small infants or children who cannot tolerate mask treatment). This method directs the mists at the patient's nose or mouth through a flex tube. It sends very little medication to the infant's lungs.

Preparation

- Explain the procedure to the parents and child.
- Select the quite area for the treatment to avoid disturbance and enhance comfort.
- Clean the nebulizer and its accessories with spirit swab.

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- Prior to using, check the nebulizer parts for cracks or damage of material inside.

Procedure

- Keep the air compressor on a flat, sturdy surface. Plug it into a grounded electrical outlet.
- Wash hands.
- Pour prescribed medicine in correct dilution in nebulizer cup and cover it with dome tightly.
- Assemble the nebulizer cup and the mouth piece or mask.
- Connect the tubing to both the nebulizer cup at one end and aerosol compressor at the other end.
- Switch on the nebulizer and keep it upright. Make sure it is working (a light mist will start to come from the back of the tube).
- Place the child in an upright position and auscultate for breath sounds.
- Place the face mask/mouthpiece correctly in place and instruct the child to take a deep breath through the mouth.
- Depending on the amount of medication to be used, the treatment will usually last 10–15 minutes.
- When the nebulizer splutters, shake or tap it once or twice. If it continues to splutter, the treatment is done.

Postprocedure Care

- Provide the child a comfortable position and encourage the child to effectively cough.
- Check the breath sounds and correlate with the preprocedural auscultation for changes.
- Check vital signs.
- If perspiration is present wipe the child's face with the face towel.
- Wash hands and replace the articles.
- Record the procedure and the vital signs in nurse's record.

General Guideline

- If the child get dizziness or jittery, stop the treatment and rest the child for about 5 minutes.

Care of Nebulizer

- After each use, the nebulizer must be cleaned.
- Dismantle the mouthpiece, nose piece, or face mask from cap, open nebulizer cup and remove baffle.
- Wash it with soap and rinse under hot tap water.
- Allow to air-dry.
- Keep the outer surface of the tubing dust free by wiping regularly with the clean and dry cotton swab daily.
- Use dry clean cloth to clean the outer part of the nebulizer.

Highlights

- Nebulization is a method of administering a drug in which the drug is dissolved in a solution, vaporized, and the vapor is inhaled.
- It is commonly indicated in children with acute respiratory tract infection.
- If the treatment is longer than 10–15 minutes, check if the mist output nebulization may be clogged or dirt can obstruct the airflow from the compressor.
- If the treatment is shorter than the normal, check to see if the medicine is leaking out of the nebulizer.
- When the nebulizer splutters, shake or tap it once or twice. If it continues to splutter, the treatment is done.
- Nebulization can be given either through mouthpiece for children ages 8 year and older or mask (children <8 years).
- In very small infants or children who cannot tolerate mask, blow method can be employed.

OXYGEN THERAPY

Definition

Oxygen therapy is the administration of the oxygen for treatment of the conditions resulting from oxygen deficiency.

Purposes

- To increase the oxygen tension of blood plasma

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- To restore the oxyhemoglobin in the red blood cells (RBCs) to the normal proportion
- To manage the condition of the hypoxia
- To maintain the ability of the cells to carry out the normal metabolic function
- To reduce the risk of complications

Indications

The indications for administering the oxygen are to correct:

- Hypoxemia (reduction in the oxygen content of the blood below physiologic levels)
- Hypoxia or anoxia (absence of adequate tissue oxygenation)

The conditions are as follows:

- Deficiency of O_2 in atmospheric air
- Ventilation perfusion abnormalities
- Impaired diffusion
- Inadequate tissue oxygenation, for example, abnormal tissue demand
- Poisoning with chemicals that alter the tissues ability to utilize oxygen, for example, cyanide poisoning
- Hemorrhage
- Shock and circulatory failure
- Children who are under anesthesia
- Asphyxia, for example, drowning, foreign body aspiration, strangulation, etc.

Principles of Oxygen Therapy

- The choice of system will depend upon the clinical status of the patient and desired dose of oxygen. For example, child with irregular respiration needs bag-mask ventilation with as high dose of O_2 as possible.
- Oxygen should be humidified to prevent dried secretions from obstructing the smaller airways.
- The effectiveness of the oxygen delivery should be monitored with pulse oximeter.
- Young children may become frightened or agitated when O_2 is administered, causing their clinical conditions to deteriorate. Therefore they should remain in a position of comfort whenever possible. A caregiver can often hold the O_2 source in proximity to or over the child's face.
- The O_2 is a drug and as such should be prescribed accordingly.

Methods of Administration

It is important to consider both the nature of respiratory illness and also the age of the child when determining the method of administration.

Methods of oxygen administration are majorly divided into two types:

- **Low-flow delivery method:** It provides oxygen at flow rates that are lower than patients' inspiratory demand.
  - ✦ Simple face mask
  - ✦ Nonrebreather face mask (mask with oxygen reservoir bag and one-way valves, which aims to prevent/reduce room air entrainment)
  - ✦ Nasal prongs (low flow)
  - ✦ Tracheotomy mask
  - ✦ Venturi mask
  - ✦ Oxyhood
- High-flow delivery method (discussed in later sections): Ventilators
- Continuous positive airway pressure (CPAP)/bilevel positive airway pressure (BiPAP) drivers: Low-flow delivery method

Simple Masks

Semi-rigid and have vents within the mask to enable dilution of O_2 **(Fig. 5.3)**.

Indications

Medium-flow oxygen desired, mild-to-moderate respiratory distress when increased oxygen delivery for short period (<12 hours).

Contraindications

Poor respiratory efforts, apnea, severe hypoxia.

Advantage

High concentration can be given.

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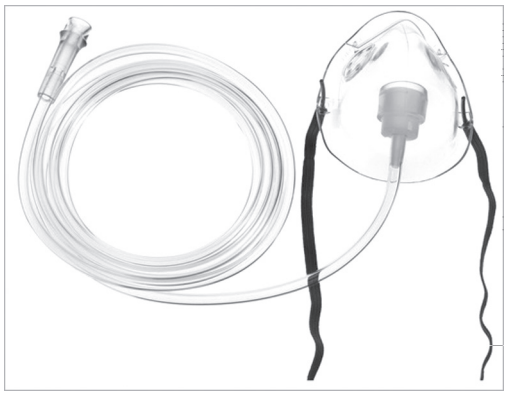

Fig. 5.3: Simple mask.

Disadvantages

- In low concentrations (<4 L), it can cause exhaled CO_2 to be rebreathed
- Uncomfortable
- Require tight seal
- Do not deliver high FiO_2
- FiO_2 varies with breathing efforts
- Interfere with eating, drinking, and communication
- Difficult to keep in position for long duration
- Skin breakdown

Venturi Masks or Hudson Masks

On the bottom of the mask is a barrel with holes in the side. The position and size of these holes determine the percentage of O_2 that is administered to the child.

These masks are available in different color codes **(Table 5.1)**.

Indications

Venturi masks are used in the situations where exact amount of oxygen needs to be delivered.

Contraindications

Poor respiratory efforts, apnea, and severe hypoxia.

Advantages

- Provide a fixed concentration of O_2 safely.
- For example, chronic lung condition reduces the risk of rebreathing the exhaled CO_2.

Table 5.1: Types of venturi masks and their flow rates.

Color	*Required flow rate*	*FiO_2*
Blue	2–4 L/min	24%
White	4–6 L/min	28%
Yellow	8–10 L/min	35%
Red	10–12 L/min	40%
Green	12–15 L/min	60%

Disadvantages

- Expensive
- Need to be discarded if a higher or lower concentration of O_2 is required

Nonbreathing Masks

These masks are used in emergency situation as they have a large reservoir that enables only O_2 to be breathed by the child, preventing the inhalation of the mixed gases, the percentage administered O_2 is approximately 99. The initial amount of O_2 flow through this mask should be set at 15 L but it is important to make sure that the bag attached to the mask is inflated before putting the mask on the child **(Fig. 5.4)**.

Indications

High FiO_2 requirement >40%.

Contraindications

Poor respiratory efforts, apnea, severe hypoxia.

Advantages

- Highest possible FiO_2 without intubation
- Suitable for spontaneously breathing patients with severe hypoxia

Disadvantages

- Expensive
- Require tight seal, uncomfortable, interfere with eating and drinking, not suitable for long-term use

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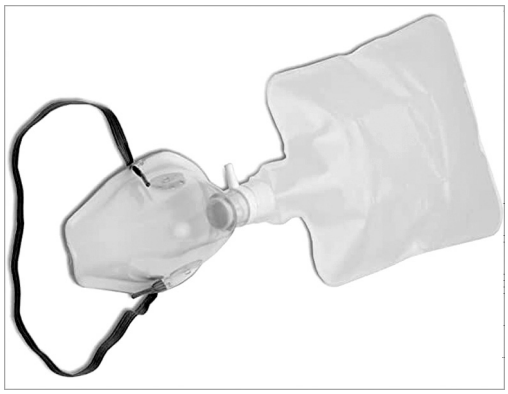

Fig. 5.4: Nonbreathing mask.



Fig. 5.5: Nasal prongs.

- Malfunction can cause CO_2 buildup, suffocation

Nasal Cannula or Prongs

These are small plastic tubes that are inserted into each nostril. If the child is very young then, the prongs need to be secured with tape on the cheeks **(Fig. 5.5)**.

Advantages

- Often tolerated well by children
- They can continue to feed and play without mask coming in the way and can be easily observed.

Disadvantages

It is difficult to give a higher flow rate of O_2 as humidification is said to be inadequate and nasal mucosa became uncomfortable for the patient.

Tracheostomy Mask

A tracheostomy mask, sometimes referred to as a tracheostomy collar, is a small mask that fits over the patient's tracheostomy site. An adjustable elastic strap that fits around the patient's neck holds it in place **(Fig. 5.6)**.

The mask has an exhalation port that remains patent at all times and a port that connects to the oxygen source with large-bore tubing. The flow rate is usually set at 10 L/min, with a nebulizer set at the appropriate oxygen concentration.

Head Boxes (Hood)

The box is placed over the top of the infant's head and also his or her upper body.

Advantages

- It will enable the administration of O_2 to an infant if he or she will not tolerate nasal prongs or masks or a higher percentage of O_2 is required than can be administered through other methods **(Fig. 5.7)**.
- It allows the nurse to be able to see the baby.

Disadvantages

- The O_2 going into the head boxes can be variable and the concentration changes if the top of the box is opened often to care the baby.

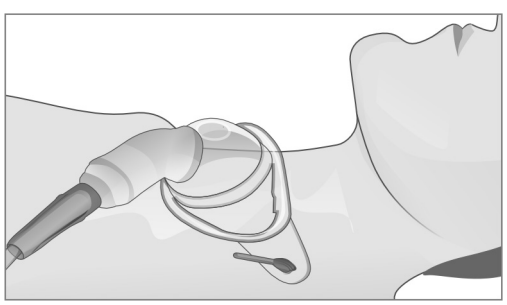

Fig. 5.6: Tracheostomy mask.

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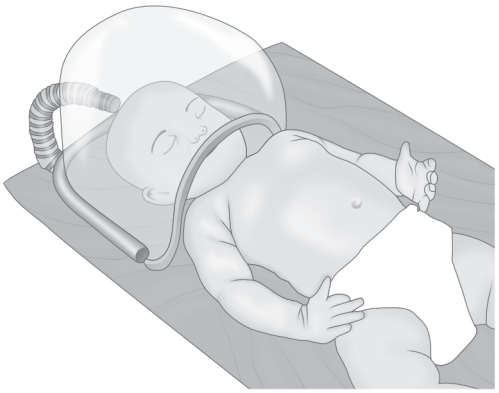

Fig. 5.7: Oxyhood.

- O_2 could be blown directly onto the face of the baby. Cold air can cause the diving reflex and can precipitate bradycardia episodes.

Oxygen delivery using different devices **(Table 5.2)**.

Criteria for Selection of Oxygen Delivery Method

Oxygen delivery method selected depends on:

- Age of the patient
- Oxygen requirements/therapeutic goals
- Patient tolerance to selected interface
- Humidification needs

Nurse's Responsibility in O_2 Administration

Prevention of Accidents and Complications

- Any child receiving O_2 therapy should not play friction toys or use a nylon or wool blanket.
- O_2 concentration must be measured near the child's head with an analyzer. Prolonged exposure to the high concentrations can be toxic to certain tissue (retina in preterm babies and lungs in all children).
- Observe the child constantly and monitor for any complications.

Table 5.2: Oxygen delivery through different devices.

Type of device	*Description*	*Flow rate*
Simple mask	Requires a fairly high oxygen flow to prevent rebreathing of carbon dioxide. About 75% of the inspired volume is room air that the patient breathes through the holes in the side of the mask. An accurate FiO_2 is difficult to estimate	8–12 L/min; FiO_2: 35–65%
Nonbreather face mask	The reservoir bag allows a higher FiO_2 to be administered. At flow rate slower than 6 L/min, the risk of rebreathing carbon dioxide increases. A valve closes during expiration so that exhaled air does not enter the reservoir bag and prevent rebreathing. The valves on the side ports of the mask open during exhalation but close during inspiration; thus prevent the rebreathing of room air	6–15 L/min; FiO_2: 60–100%
Venturi mask	Different size adaptors are used to deliver a fixed or predicted FiO_2. The FiO_2 level depends upon the flow rate and port size	2–15 L/min; FiO_2: 24–60%
Nasal prongs	Can tolerate well and easy to use. FiO_2 varies depending on the flow rate and depth of the patient's breathing	▪ 1–2 L/min; FiO_2: 24–38% ▪ 3–4 L/min; FiO_2: 30–35% ▪ 5–6 L/min; FiO_2: 38–44%

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Assessment and Documentation

- Proper recording of the procedure includes time of starting, amount of flow, and duration.
- Assess the airway and position the child accordingly.
- Clinical assessment and documentation, including, but not limited to, cardiovascular, respiratory, and neurological systems, should be done at the commencement of each shift and with any change in patient condition.
- Check and document oxygen equipment setup at the commencement of each shift and with any change in patient condition.
- Hourly checks should be made for the following:
  - ✦ Oxygen flow rate
  - ✦ Patency of tubing
  - ✦ Humidifier settings (if being used)
- Hourly checks should be made and recorded on the patient observation chart for the following (unless otherwise directed by the treating medical team):
  - ✦ Heart rate
  - ✦ Respiratory rate
  - ✦ Signs of respiratory distress, such as nasal flaring
  - ✦ Oxygen saturation

Weaning from Oxygen

- Unless clinically contraindicated, an attempt to wean the child from oxygen therapy should be attempted at least once per shift.
- Criteria for weaning:
  - ✦ Child is clinically stable.
  - ✦ Vital parameters are within normal limits.
  - ✦ No signs of respiratory distress.
  - ✦ Taking oral feed.
  - ✦ Child is alert and conscious, skin is pink.
- Monitor the child continuously after cessation of oxygen therapy.

General Guidelines for Commencing/ Increasing/Stopping Oxygen Therapy

Commencement or Increase of Oxygen Therapy

Oxygen therapy should be commenced if:

- SpO_2 is <92% (PaO_2 <80 mm Hg) in patients without cyanotic heart disease.
- SpO_2 is <70% (PaO_2 <37 mm Hg) in patients with cyanotic heart disease who have had cardiac surgery.
- SpO_2 is <60% (PaO_2 <32 mm Hg) in patients with cyanotic heart disease who are waiting for cardiac surgery.
- <91% in premature and newborn neonates.
- Persistently <90% for infants with bronchiolitis.

Reduction or Cessation of Oxygen Therapy

Oxygen therapy should be reduced or in ceased if:

- SpO_2 is ≥92%.
- SpO_2 is ≥90% for infants with bronchiolitis.
- The child with cyanotic heart disease reaches their baseline SpO_2.

Complications

- Retinopathy of prematurity or retrolental fibroplasia
- Bronchopulmonary dysplasia
- Infection
- Fire hazards
- O_2 toxicity causes nausea or vomiting, anxiety and visual disturbance, muscle twitching, and seizures.
- O_2 induced apnea
- Drying of mucus membrane of respiratory tract
- Atelectasis due to increased O_2 concentration and elimination of nitrogen

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Highlights

- Oxygen therapy is the administration of the oxygen for treatment of the conditions resulting from oxygen deficiency.
- The indications for administering the oxygen are to correct (1) hypoxemia and (2) hypoxia or anoxia.
- The O_2 is a drug and as such should be prescribed accordingly.
- It is important to consider both the nature of respiratory illness and also the age of the child when determining the method of administration.
- Methods of oxygen administration are majorly divided into two types: Low-flow delivery method and high-flow delivery method.
- Oxygen therapy should be commenced if:
  - SpO_2 is <92% (PaO_2 <80 mm Hg) in patients without cyanotic heart disease.
  - SpO_2 is <60% (PaO_2 <32 mm Hg) in patients with cyanotic heart disease who are waiting for cardiac surgery.
  - <91% in premature and newborn neonates.
  - Persistently <90% for infants with bronchiolitis.

CHEST PHYSIOTHERAPY

Definition

Chest physiotherapy (CPT) is an airway clearance technique that combines manual percussion of the chest wall by the caregiver, strategic positioning of the patients for mucus drainage with cough and breathing techniques.

Indications

- In conditions with copious retention of airway secretions, such as bronchiectasis and cystic fibrosis with thick mucus secretion leading on to segmental lesions/collapse
- In children with weak respiratory mechanics, such as cerebral palsy and neuromuscular disorders, for example, spinal muscular atrophy
- In children with weak cough, such as vocal cord palsy and brainstem lesion
- In kyphoscoliosis
- In bedridden children, immobilization may limit or prevent physical exercise, impairing their ability to maintain aerobic capacity and lung volume.
- In acute severe asthma (in the presence of atelectasis)
- In pneumonia (consolidation phase)
- In intensive care unit, CPT is the treatment of choice for only patients with acute lobar atelectasis.
- Prophylactic drainage of contralateral normal lung following the drainage of diseased lung.

Contraindications

See **Table 5.3** for details.

Techniques

- Positioning (postural drainage)
- Chest percussion
- Vibration
- Thoracic squeezing
- Cough stimulation

Positioning (Postural Drainage)

It is mere positioning of the child with assistance of gravity to stabilize the secretions toward the main bronchus **(Fig. 5.8)**.

Upper Lobe

- **Apical bronchus:** Sitting upright with slight variation according to the position of the lesion, that is, slightly leaning backward, forward, or sideways
- **Anterior bronchus:** Lying supine with the knees slightly flexed
- **Posterior bronchus:**
  - ✦ Right—lying on the left side and turn his face 45° resting against a pillow, with another pillow supporting the head
  - ✦ Left—lying on the right side turning his/her face 45° with three pillows arranged to lift the shoulders by 12 inches.

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Table 5.3: Contraindications for chest physiotherapy.

Sl. No.	*Positioning*	*Conditions*
1.	All positioning	Raised ICP, head and neck injury until stabilized, active hemorrhage with hemodynamic instability, recent spinal surgery or acute spinal injury, active hemoptysis, empyema, bronchopleural fistula, large pleural effusions, pulmonary embolism, pulmonary edema associated with CHF, confused or anxious patients who do not tolerate position change, rib fracture with or without flail chest, surgical wound or healing tissue
2.	Trendelenburg	Raised ICP, patients in whom increased ICP is to be avoided, uncontrolled hypertension, distended abdomen, esophageal surgery, recent gross hemoptysis, uncontrolled airway with risk for aspiration (tube feeding, or recent meal)
3.	Reverse Trendelenburg	Hypotension or vasoactive medication
4.	External manipulation of thorax	Subcutaneous emphysema, pneumatoceles, pneumothorax, recent epidural spinal infusion or spinal anesthesia, recent skin grafts or flaps on the thorax burns, open wounds and skin infection of the thorax, suspected pulmonary TB, lung contusion, bronchospasm, osteomyelitis of the ribs, osteoporosis, coagulopathy, severe thrombocytopenia, complaint of chest wall pain, recently placed transvenous pacemaker or subcutaneous pacemaker

(ICP: intracranial pressure; TB: tuberculosis; CHF: congestive heart failure)

Middle Lobe (Right)

Lateral and medial bronchus—lying supine with the body a quarter turned to the left maintained by a pillow under the left side from shoulder to hip and foot end raised by 14 inches (35 cm).

Lingular (Left)

Superior and inferior bronchus—lying supine with the body a quarter turned to the right maintained by a pillow under the left side from shoulder to hip and foot end raised by 14 inches (35 cm).

Lower Lobe

- Apical basal bronchus—lying prone with a pillow under the hips.
- Anterior basal bronchus—lying supine with the buttocks resting on a pillow and the knees flexed. Foot of the bed raised by 18 inches (45 cm).
- Posterior basal bronchus—lying prone with a pillow under the hips. Foot of the bed raised by 18 inches (45 cm).
- Lateral basal bronchus—lying on the opposite side with a pillow under the hips. Foot of the bed raised by 18 inches (45 cm).
- Basal (cardiac) bronchus—lying on the right side with a pillow under the hips. Foot of the bed raised by 18 inches (45 cm).

Chest Percussion

- Depending on the available area, the therapist can use a single or both cupped hands or three fingers with the middle finger tented or a face mask with either the part covered or occluded by a finger and strike repeatedly at a rate of 3/s over the part of the bronchopulmonary segment, which needs to be drained **(Fig. 5.9)**.
- The cupped hand/mask tends to trap a cushion of air, which softens the blow while

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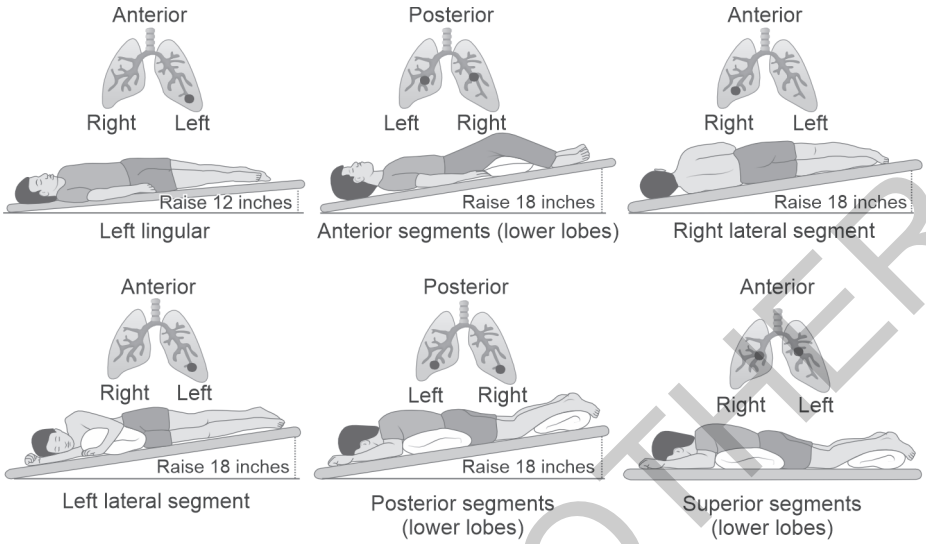

Fig. 5.8: Different positions for postural drainage.

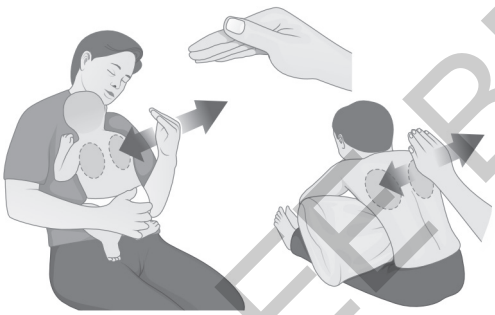

Fig. 5.9: Chest percussion in pediatric clients.

striking, and the air column inside the cupped hand causes effective dislodgement of the secretions in the underlying bronchus as the compression wave is presumably transmitted to the underlying bronchus and gravitational aid causes flow of secretions from the bronchus toward the glottis.

- The movement should be only at the wrist without causing pain or discomfort and can be done throughout inspiration and expiration; rings (if any) should be removed before percussion.
- Percussion should be vigorous but not painful and should not be done on bare skin, but over soft comfortable clothing or towels.
- Properly done percussion produces only sound rather than discomfort which the child gets used to in due course.
- Mechanical percussors are also available and may be useful in adolescents.

Vibration

- In this a rapid vibratory impulse is transmitted through the chest wall from the flattened hands of the therapist by isometric alternate contraction of forearm flexor and extensor muscles, to loosen and dislodge the airway secretions.
- Vibration is a technical procedure and is usually effectively executed only by a physiotherapist.

Thoracic Squeezing

- The expiratory phase is reinforced in this maneuver. The child is asked to take a deep breath and then exhale through the mouth as completely and rapidly as possible, as would be done for a forced expiratory volume determination.

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