National Guidelines on Use of Oxygen Therapy for Management of Newborn and Paediatric Hypoxemia

Book · December 2020

CITATIONS
0

READS
1,001

2 authors:

A N M Ehtesham Kabir

26 PUBLICATIONS **81** CITATIONS

SEE PROFILE

Sharmin Afroze

Dr. M R Khan Shishu Hospital & Institute of Child Health

77 PUBLICATIONS **70** CITATIONS

SEE PROFILE

NATIONAL GUIDELINES ON USE OF OXYGEN THERAPY FOR MANAGEMENT OF NEWBORN AND PAEDIATRIC HYPOXAEMIA

স্বাস্থ্য ও পরিবার কল্যাণ মন্ত্রণালয়

USAID FROM THE AMERICAN PEOPLE

Foreign, Commonwealth & Development Office

World Health Organization

unicef

For more Information, please contact:

Programme Manager
NNHP and IMCI Section
Directorate General of Health Services
EPI Building, Mohakhali, Dhaka-1212

Printed with support from UNICEF Bangladesh

Special Care Newborn Unit (SCANU) at Kurigram District Hospital, 21/22 March, 2018

NATIONAL GUIDELINES ON USE OF OXYGEN THERAPY FOR MANAGEMENT OF NEWBORN AND PAEDIATRIC HYPOXAEMIA

National Newborn Health Programme and IMCI Section
Directorate General of Health Services

Ministry of Health and Family welfare

Funded By:

UNICEF Bangladesh, with support from
U.S. Agency for International Development, Bangladesh
Foreign, Commonwealth and Development Office (FCDO) of
the United Kingdom

December, 2020

Acronyms

AHA	American Heart Association
ARI	Acute Respiratory Tract Infections
BP	Blood Pressure
CFT	Capillary Filling Time
COVID 19	Corona virus Disease 2019
CPAP	Continuous positive airway pressure
HBB	Helping Babies Breathe
ICU	Intensive Care Unit
IMCI	Integrated Management of Childhood Illness
IPC	Infection Prevention Committee
LED	Light Emitting Diodes
MDG 4	Millennium Development Goal 4
PEEP	Positive End Expiratory Pressure
PPHN	Persistent Pulmonary Hypertension of Newborn
PPE	Personal Protective Equipment
RDS	Respiratory Distress Syndrome
ROP	Retinopathy of Prematurity
SCANU	Special Care Newborn Unit
SDG	Sustainable Development Goal
TTNB	Transient Tachypnea of newborn
VLBW	Very Low Birth Weight
WHO	World Health Organization

Contributors:

(Not according to seniority or precedence)

Prof Mohammod Shahidullah, President BMDC and Chairperson, NTWC-NBH

Prof. Manzoor Hussain, President, Bangladesh Paediatric Association (BPA)

Prof. Tahmina Begum, President, Bangladesh Neonatal Forum (BNF)

Prof. Md. Abdul Mannan, Professor, Department of Neonatology, BSMMU

Prof. Sanjoy Kumer Dey, Professor, Department of Neonatology, BSMMU

Professor. Shahida Akter, Department of Paediatrics, BIRDEM Hospital, Dhaka

Dr. Sharmin Afroze, Assistant Professor, Neonatology, Dr. M R Khan Shishu (Children) Hospital & Institute of Child Health

Dr. Md. Shamsul Haque, Line Director, MNCAH, DGHS

Dr. Muhammad Shariful Islam, Program Manager, NNHP& IMCI, MNCAH, DGHS

Dr. Md. Jahurul Islam, DPM, Newborn Health, NNHP&IMCI, MNCAH, DGHS

Dr. Sabina Ashrafee Lipi, DPM, Training & Child Injury, NNHP&IMCI, MNCAH, DGHS

Dr. Md. Shah Alam Husam, DPM, Coordination & Logistics, NNHP&IMCI, MNCAH, DGHS

Dr. Ashfia Saberin Rumana, Medical Officer, NNHP & IMCI, MNCAH, DGHS

Dr. Md Ziaul Matin, Health Manager, Maternal, Newborn & Child Health, UNICEF

Dr. Shamina Sharmin, Health Specialist, Newborn and Child Health, UNICEF

Dr. Mahbuba Khan, NPO - Making Pregnancy Safer and Healthy Aging, WHO

Dr. Farhana Akhter, Maternal and Newborn Health Specialist, USAID, Bangladesh

Dr. Afsana Karim, Senior Technical Advisor-MNH, MaMoni MNCSP, Save the Children in Bangladesh

Dr. ANM Ehtesham Kabir, Focal Point, Newborn & Child Health Cell, NNHP & IMCI, MNCAH

Table of Contents

1. Introduction

1.1. Background

The World has made remarkable progress in child survival in the past three decades. The global under-five mortality rate declined by 59 per cent, from 93 deaths per 1,000 live births in 1990 to 38 in 2019. Despite this considerable progress, around 14,000 under-five deaths occurred every day and most of these deaths are preventable and easily treatable.

Pneumonia is one of the most common global childhood illnesses and one of the leading causes of mortality in under five children. It contributes to 21% of all deaths in this age category and it is estimated that of every 1000 children born alive, 12–20 will die from pneumonia before their fifth birthday

Hypoxemia or insufficient oxygen in blood is a common and potentially lethal complication of pneumonia and other ARI (Acute Respiratory Tract Infections) such as bronchiolitis, bronchial asthma in under five children. According to World Health Organization, 13.3% of the under- five pneumonic children are hypoxemic. Early detection of hypoxemia, and oxygen therapy can improve the outcome of children with these conditions.

Neonatal death constitutes 47% of all under five deaths worldwide with about one third dying on the day of birth and close to three quarters dying within the first week of life[7].It results from three common conditions of newborns such as perinatal asphyxia, neonatal sepsis and prematurity related complications. These conditions can also lead to hypoxemia and subsequently deaths especially in developing countries.

Despite its significant importance in virtually all types of acute severe illness, hypoxemia is often not well recognized or managed in many resource limited countries including Bangladesh. If oxygen delivery is available, supplies are often unreliable and the benefits of treatment may be decreased by poor maintenance, untrained staff and inadequate guidelines.

Bangladesh has experienced a significant reduction of child mortality over the past decades which helped achieve the Millennium Development Goal 4 (MDG 4) target. But the mortality among under-5 aged children is still relatively high that is 45 deaths per 1000 live births and neonatal mortality accounts for 67% of all under-5 deaths which requires a substantial effort to decelerate the current rate of under-5 mortality as well as to achieve the Sustainable Development Goal (SDG) targets.

Among the comprehensive measures, timely detection of hypoxemia and appropriate oxygen therapy is one of the key interventions. Health workers should know the clinical signs for hypoxemia and ways of early detection. They should also know about monitoring while baby is getting oxygen therapy. Oxygen should be used judiciously like a prescribed medicine where health professionals will know when to start oxygen at which flow rate, what things to monitor and when to stop.

Like other developing countries Bangladesh is growing experience in the clinical, organizational, biomedical technology and training aspects of setting up and sustaining effective oxygen delivery systems in hospitals. Increasing availability of reliable oxygen sources and trained manpower in assessing the adequacy of oxygen therapy can reduce child death from pneumonia and other respiratory diseases by about one third which is evident from many studies.

This guideline focuses on clinical aspects as well as rational use of oxygen therapy for children in health facilities of Bangladesh. We hope that this will improve oxygen delivery system nationwide by highlighting practical aspects of oxygen therapy for health care providers, biomedical engineers and administrators.

1.2. Purpose of the guideline

This guideline is focused on improving the quality of care for severely ill children in health facilities. It describes the importance for detection of hypoxemia, use of pulse oximetry, oxygen delivery system and monitoring skills and parameters for sick children while on oxygen therapy.

The main purpose is to:

- Increase awareness for improving the availability of oxygen therapy for children
- Increase identification and management of hypoxemia in severely ill children
- Increase the availability of oxygen therapy in all health facilities
- Improve monitoring of patients while on oxygen therapy
- Increase practical skills of health care providers for oxygen therapy
- Ensure use of infection prevention measures during oxygen therapy

This guideline will be a useful tool for health care providers involved in care of children and will definitely help in rational and appropriate use of oxygen.

2. Hypoxemia and Hypoxia

2.1: Definition

- Hypoxemia means low level of oxygen in blood (low blood oxygen saturation)
- Hypoxia is inadequate oxygen in tissues for normal cell and organ function and hypoxia results from hypoxemia.
- Hypoxemia can lead to hypoxia and if left untreated, it leads to organ dysfunction and death.

Oxygen saturation:

Arterial oxygen saturation is referred to as SaO2 and SpO2

- When arterial haemoglobin oxygen saturation is measured by arterial blood gas analysis it is called SaO2.
- When arterial haemoglobin oxygen saturation is measured non-invasively by pulse oximetry, it is called SPO2 (Haemoglobin oxygen pulsed saturation).

2.2. Common causes of Hypoxemia

Neonates	Children
• Respiratory distress syndrome • Perinatal asphyxia • Transient Tachypnea of newborn • Pneumonia • Meconium aspiration syndrome and other aspirations • Congenital heart diseases • Anaemia • Any sick neonate having prematurity or sepsis or seizure are prone to have apnea. Apnea further leads to hypoxemia and slow the heart rate and reduces oxygen delivery to tissue. • Congenital malformations (e.g. congenital diaphragmatic hernia)	• Pneumonia • Bronchiolitis • Asthma • Heart failure or cardiac arrest • Meningitis • Sepsis • Anaemia

- Hypoxemia is more common in lower than upper respiratory tract infections.
- Pneumonia in children is most commonly due to bacteria (Streptococcus pneumoniae and Haemophilus influenzae) and viruses (respiratory syncytial virus, influenza virus). Other pathogens are common in certain high risk groups.

3. Detection of hypoxemia in children

Hypoxemia can be detected by certain clinical signs, use of pulse oximeter and blood gas analysis.

3.1. Clinical Signs of hypoxemia

Different clinical signs are indicative of hypoxemia in neonates and children.

It is essential for the health workers to know about these signs for early recognition and management of sick, hypoxemic patients.

Neonates:

- Fast breathing
- Cyanosis
- Grunting
- Apnea in very low birth weight infants and premature babies

(As features are non-specific in neonates, screening by pulse oximetry is the best tool).

Children:

- Central cyanosis (Bluish discoloration of the tongue or gums)
- Fast breathing: It is best measured by observing movement of chest wall for 60 seconds. Age specific definition for fast breathing is listed below:

If the child is:	Child has fast breathing if breath count for 1 minute[12]
Less than 2 months	60 breaths per minute or more
2 months up to 11 months	50 breaths per minute or more
12 months up to 5 years	40 breaths per minute or more

(Ref: Integrated Management of Childhood Illness, 2016)

- Head nodding, grunting or nasal flaring
- Severe lower chest in-drawing
- Inability to drink or feed (when due to respiratory distress)
- Coma, severe lethargy, prostration or prolonged convulsions (lasting for more than a few minutes) put a child to a significant risk for hypoxemia. These conditions are associated with depression of the respiratory drive, leading to hypoventilation and hypoxaemia.

3.2 Use of Pulse Oximeter

- Pulse oximetry is the most accurate, non-invasive method used to measure the percentage of oxygenated haemoglobin in arterial blood (SpO2).
- It is useful in detection as well as monitoring of hypoxemia **(Annexure I)**

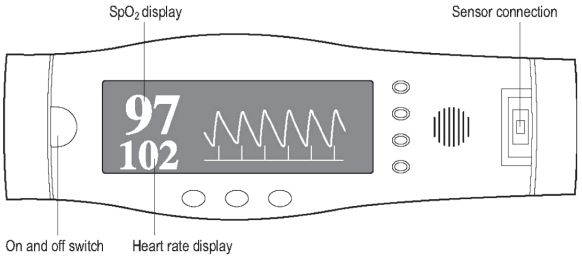


Figure -1: Pulse oximeter

3.3. Blood Gas Analysis

It is the gold standard for detecting hypoxemia.

It measures the partial pressure of oxygen (PaO2) and carbon dioxide in blood, blood pH and the concentrations of the main electrolytes.

Blood gas analysers are very expensive, and the chemical reagents represent a high recurrent cost. The method is invasive and uncomfortable, as it requires taking blood.

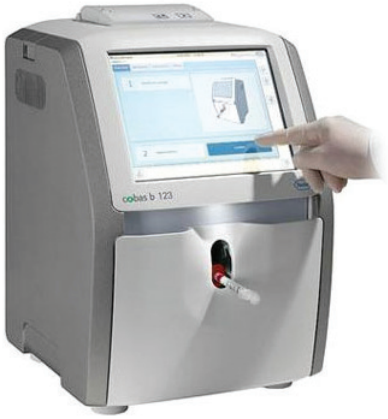


Figure-2: Blood gas analyser

4. Indication for oxygen therapy

4.1. Neonates

Oxygen therapy in newborn infants, particularly when they are born preterm, should reflect the fact that in the first hours of life they have lower normal oxygen saturation than older newborn. It may take an hour or more for oxygen saturation to reach levels above 95%.

Recommended targeted Saturation (pre-ductal SpO2) after birth:

Age after birth	Targeted Pre-ductal saturation (SpO2)
1 minutes	60 - 65%
2 minutes	65 – 70%
3 minutes	70 – 75%
4 minutes	75 – 80%
5 minutes	80 – 85%
10 minutes	85 – 95%

*Pre-ductal saturation refers to arterial oxygen saturation in vessels originating from the aorta before the ductus arteriosus. Pre ductal values are recorded at right hand.

*Pulse oximetry should be used to monitor SpO2 over right hand, which should be maintained between 90-95% to prevent eye damage.

Oxygen therapy needs to be initiated in following conditions:[8,18-19]

Preterm Newborns	Term/Near Term Newborns	Irrespective of gestational age
• Respiratory Distress Syndrome (RDS) • Delayed adaptation	• Transient Tachypnea of newborn (TTNB) • Perinatal asphyxia • Meconium aspiration syndromes • Congenital malformations: Congenital diaphragmatic hernia • Persistent pulmonary hypertension of newborn (PPHN)	• Pneumonia • Sepsis • Apnea • Congenital heart disease (except duct dependent lesions) • Meningitis • Apnea

Special consideration:

Neonatal Resuscitation for asphyxiated newborns:

Perinatal asphyxia is a common neonatal problem which can lead to hypoxaemia. Approximately 85% of newborn infants born at term have been shown to initiate spontaneous respiration within 10-30 seconds of birth with additional 10% respond to drying and stimulation and other 3 % initiate breathing after positive pressure ventilation; 2% need intubation to support respiratory function and 0.1% require chest compression and/or adrenaline.

The primary respiratory problem in most cases of perinatal asphyxia is lack of initiation of ventilation or lack of effective ventilation, so the most important intervention is to assist the neonate to take breaths more effectively.

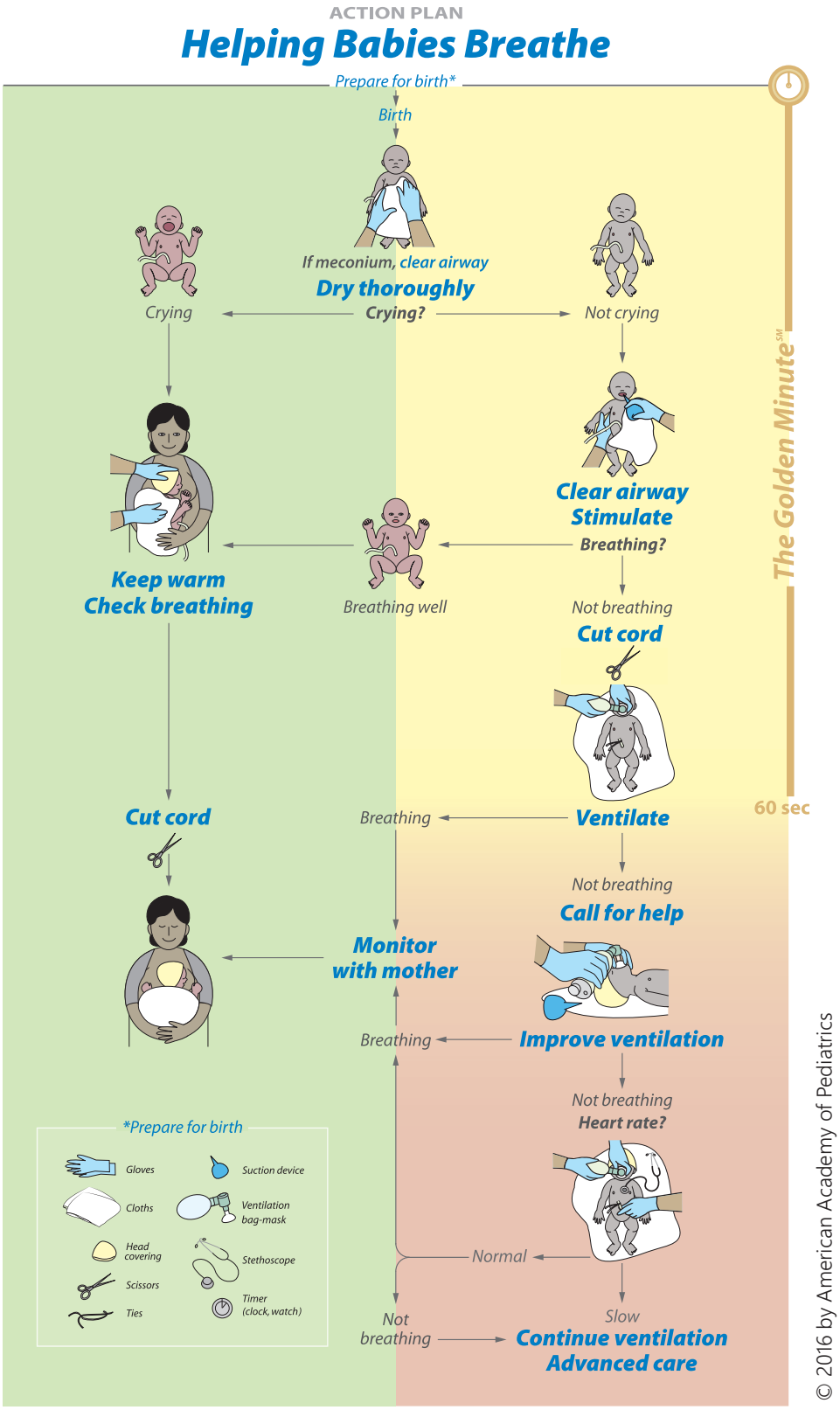


Figure-3: Helping Babies Breathe – Flow chart

(**When facilities are available, advanced resuscitation measures such as intubation, chest compression and drugs can be used to save newborn life)

*During resuscitation, whatever the gestational age or birth weight usually oxygen is not required. If with bag mask ventilation with room air (21% oxygen) and with proper maintaining of the HBB steps, oxygen saturation of infant does not improve to target level, then oxygen can be started with lower FiO2.

Latest Oxygen targets in different gestation during resuscitation:

AHA (American Heart Association) 2019
When newborn term or preterm (> 35 weeks' gestation) infants require positive pressure ventilation, bag-mask resuscitation with air containing 21% oxygen is effective **For preterm infants (< 35 weeks' gestation), bag-mask resuscitation with 30% oxygen should be used.** ***In some trials, for resuscitation of preterm infants < 32 weeks gestation, use of FiO2 30% has been suggested*

**Developed countries have blended oxygen facility and during resuscitation, if oxygen is required, they can use it and can titrate it accordingly such as:

- Child requiring bag mask ventilation use FiO2 of 40%
- Child requiring chest compression in any stage of resuscitation, use FiO2 of 100%

** Eye damage, called retinopathy of prematurity, can result from exposure of very low birth weight infants to excessive oxygen. Infants at highest risk are those born at < 32 weeks' gestation or weighing <1250 g; the smaller the infant, the greater the risk.

Recommended oxygen saturation target for preterm is between 90-95%.

4.2. Children

Indications:

- Any child with a SpO2 < 90% should receive oxygen.

When a child presents with cough or difficult breathing, will be classified according to IMCI and if oxygen saturation by using pulse oximeter is found < 90%, oxygen therapy is required especially in children aged 2 month up to 5 years. **(Annexure II)**

IMCI Classification of a child with cough or difficult breathing:

a. Sick child aged 2 months up to 5 years

b. Sick young infants aged 0 month up to 2 months

(a) Sick Child (2 months up to 5 years):

If a child is classified with **SEVERE PNEUMONIA OR VERY SEVERE DISEASE**, he is very sick. He needs to be sent to hospital **URGENTLY** so that he receives oxygen, bronchodilator or antibiotic. Give him the first dose of intramuscular Gentamicin and oral Amoxicillin.

(b) Sick young infants (0-2 months):

Possible Serious Bacterial Infection or Very Severe Disease- Fast Breathing Pneumonia (0-6 days):

Young infants with this classification having fast breathing 60 breath/ minute or more for age 0-6 days. Treat the infants presenting with isolated fast breathing with Oral Amoxicillin for 7 days.

In case of **referral** compliance: The infant will be administered 1st dose of oral Amoxicillin and **referred URGENTLY** to hospital with **referral** slip containing referral note. Mother and family members must be taught and advised on frequent breast feeding on way to prevent low blood sugar. They must also be advised on keeping the baby warm.

Fast Breathing Pneumonia (7-59 days):

Young infants with this classification have fast breathing (60 breaths/ minute or more for age 7-59 days). Give the first dose of oral Amoxicillin dispersible tablet twice daily for 7 days and ask the family to continue this oral antibiotic treatment for 7 days twice daily. The mother and the family member must be taught and advised on frequent breastfeeding to prevent low blood sugar.

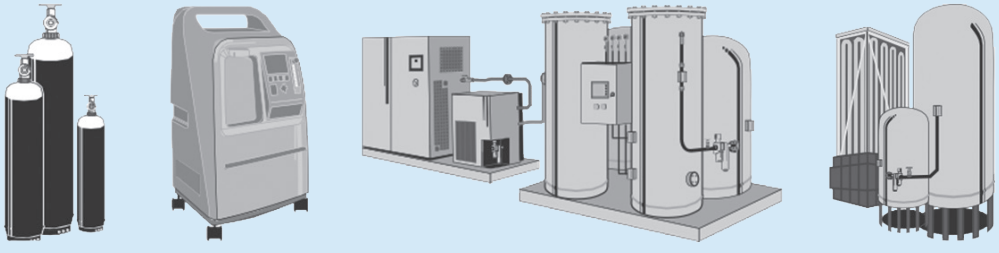
(Module on Integrated Management of Childhood Illness, 2016).

5. Oxygen delivery system

A complete oxygen delivery system comprises of its source, distribution, regulation and conditioning, delivery and maintenance of the system. However, not all of these components are always necessary or appropriate in different context.

5.1. Sources of oxygen

The sources of oxygen and its delivery method usually depend on the facility and the availability of resources. The most common sources of oxygen will be used are cylinders and concentrators **(Annexure III).**

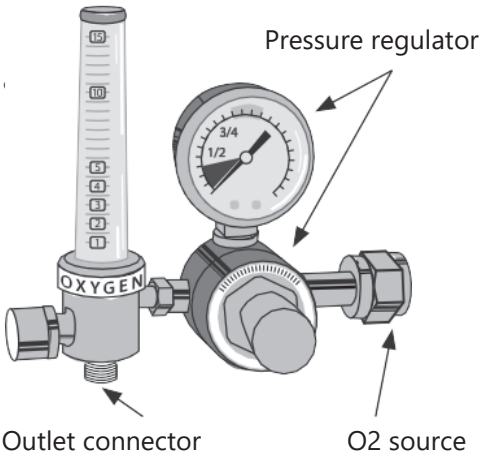
Oxygen Cylinders	Oxygen concentrators	Oxygen plant	Bulk liquid oxygen
- Oxygen produced in manufacturing plants by cooling air until it liquefies > distilling the liquid to separate pure oxygen> passed through a liquid oxygen pump into cylinders.	- It draws in air from the environment, (21% O2 78% N2 and 1% other gases)> extract the nitrogen to leave almost pure oxygen -Supply oxygen at a concentration of 90–96% with a maximum flow rate between 5-10 L/min[2]	- It is a large, onsite, central source of oxygen that is piped directly to terminal units within patient areas.	- Bulk liquid oxygen is generated off site and stored in a large tank and supplied throughout a health facility via a central pipeline system.
- Can be used for any O2 need/ high pressure/ ambulatory/back up for other support)	- Deliver O2 bedside or close proximity to patient areas (up to 4 patients at same time when used with flow splitters or flow meters)	- Can be used for all O2 needs including high pressure supply	- It can be used for all oxygen needs, including high pressure supply and in facilities where power supply is intermittent or un-reliable.
- Energy consuming process - Regular filling is required	- Portable - Requires continuous and reliable power - Need cylinders for back up	- Plants can generate oxygen and it requires a reliable source of power.	
Can be used at primary/2ndary and possibly tertiary level hospital	Can be used at primary/2ndary and possibly tertiary level hospital	Secondary and tertiary level	Secondary and tertiary
			

5.2. Distribution

To supply the oxygen as clean, highly pure and under stable pressure it is distributed via central pipe system or within tube.

5.3. Regulation and conditioning

- There are several devices which play different roles in regulation and conditioning of oxygen gas for the delivery of O2 therapy to patients.
- Thorpe tube flow meters are calibrated to a specific medical gas (oxygen or air) and come in dedicated flow rate ranges appropriate for different patient groups (e.g. neonate, infant, child, adult). **(Annexure-IV)**



Devices for O2 regulation and conditioning:

- Regulator
- Flow meter (Thorpe tube)
- Flow splitter (flow meter stand)
- Humidifier (heated and non-heated)
- Blender
- CPAP
- Ventilator

Figure-4: Thorpe Tube flow meter with pressure regulator and outlet connector

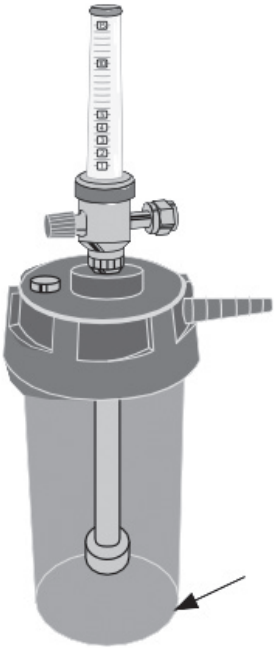


Figure-5: Humidifier bottle

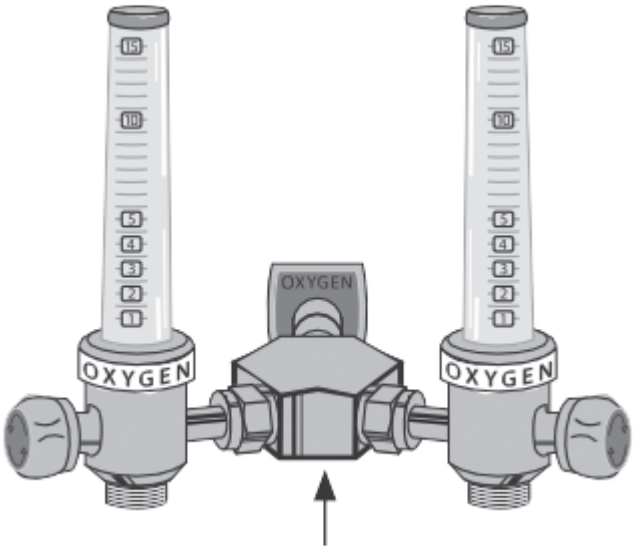
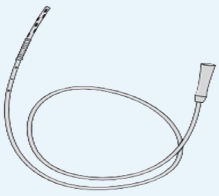
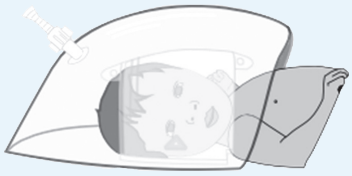


Figure-6: Flow splitting device (dual flow meter from a single wall source for use in two patients)

5.4. Oxygen delivery devices

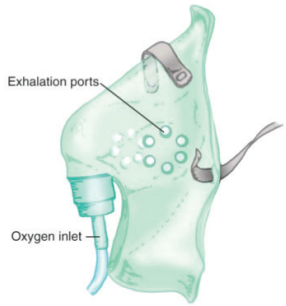
There are devices those connect oxygen source with the patient for delivery of oxygen. The selection of devices depends on clinical needs of patient and device capability. ***Among the non-invasive devices, use of head box, face mask are discouraged now a days due to risk of carbon dioxide accumulation (hypercapnia) which is harmful for children.***

Description and comparison of different oxygen delivery devices: (Annexure V)

	Nasal cannula or prongs	Nasal catheter	Head box/Face mask
Type	Semi invasive	Semi invasive	Non-invasive
Description	Plastic tubes that end in two short tapered prongs that are placed in the nostrils.	Thin, flexible tube that is passed into the nose and ends with its tip in the nasal cavity.	These are simple, partial rebreathing and non- rebreathing type
Clinical application and/or use case	Low-flow oxygen therapy	Low-flow oxygen therapy	Higher flows are required to achieve adequate concentration of oxygen and prevent carbon dioxide accumulation. (FiO2 needs to be tightly controlled)
Achievable FiO2	Depends on the patient, but up to 50–55% can be achieved		Depending on the device, can be varied from 21–100%.
Merits	Causes less interference with feeding, drinking, speaking	-Lower cost alternative to nasal cannulae -Less likely to be dislodged.	-Non-invasive -No increased risk of airway obstruction by mucus or of gastric distention.
Drawbacks	-More costly than nasal catheters. -Risk of dislodgement. -Poor quality tape can cause skin trauma	-More invasive than nasal cannulae -Insertion requires skilled trained nurse. -Can become blocked with mucus 	-Can interfere with feeding, drinking, speaking -Wasteful of oxygen. -Hypercapnia 

Description of different face masks for older children:

Simple face mask



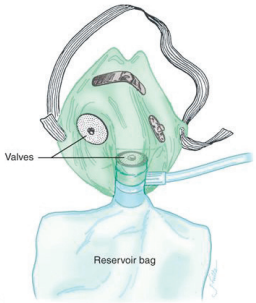
- Minimum flow rate 5 L/min and maximum flow rate 10 L/ min
- Needs to be removed while eating and sleeping
- Difficult to get a proper seal
- Possibility of dryness of eyes and accidental injury to eyes

O2 flow	Resultant FiO2
5-6	24
7-8	28
9-10	32

Partial re-breathing masks

- No valve present at mask and in between reservoir and mask
- Minimum flow rate 8 L/min
- Some amount of re-breathing is allowed
- Especially helpful in situation where oxygen supply is less
- Malfunction can lead to CO2 retention and suffocation

Non-re breathing masks



- Valve present between reservoir and mask
- Minimum flow rate 12 L/min
- Prolonged use is not recommended and is also uncomfortable

Venture masks

- It is a high flow device
- Advantage of delivering exact FiO2

Valve	Flow Rate	FiO2
Green	15	0.60
Red	10	0.40
Yellow	8	0.35
Orange	6	0.31
White	4	0.28
Blue	2	0.24

Source: Management Guideline for Paediatric COVID-19, 2nd edition, 2020

6. Continuous Positive Airway Pressure (CPAP)

Continuous positive airway pressure (CPAP) is a simple, inexpensive and gentle mode of respiratory support for infants and children. It is thought to be a bridge or missing link between oxygen therapy and mechanical ventilation in the respiratory management.

6.1. Definition

CPAP is a form of non- invasive ventilation where a positive pressure is applied in the airway of a spontaneously breathing infant throughout the respiratory cycle and thus prevents collapse of alveoli and terminal airway during expiration.

6.2. Background

In the early 1970s, Gregory et al. first described the clinical use of CPAP in preterm infants with respiratory distress syndrome (RDS). After that CPAP was widely used in many centers and till now it has proven its beneficial role regarding respiratory management of infants and children worldwide.

6.3. Beneficial role of CPAP

- Prevents alveolar atelectasis by improving and maintaining functional residual capacity (FRC)
- Corrects ventilation-perfusion abnormalities secondary to an improvement in FRC
- Reduces intrapulmonary shunting
- Decreases total airway resistance
- Regularizes breathing pattern
- Reduces work of breathing
- Improves oxygenation
- Reduces apnea

CPAP requires a source of continuous airflow (often an air compressor) and usually requires an oxygen blender connected to an oxygen source. A CPAP system is available in some hospitals but should be used only when it is reliable oxygen systems are in place, where staff are adequately trained and when close monitoring is assured.

6.4. Indication of CPAP

6.4.1. Neonates:

Common indications:

1. Respiratory Distress Syndrome (RDS)
2. Apnea of prematurity (especially obstructive apnea)
3. Post extubation in preterm VLBW infant
4. Transient tachypnea of Newborn (TTNB)/ delayed adaptation

Other indications:

1. Pneumonia
2. Meconium aspiration/ other aspiration syndromes
3. Pulmonary hemorrhage
4. Laryngomalacia/ tracheomalacia/bronchomalacia

In neonates CPAP can be provided in following ways:

- **Early CPAP:**

All preterm infants (<35 weeks') with any sign of respiratory distress (tachypnea/chest in-drawing/grunting) should be started immediately on CPAP.

(Prophylactic CPAP in preterm babies is not recommended now a days).

6.4.2. Infant and Children:

It is indicated for infants and children with severe respiratory distress, hypoxaemia or apnoea despite receiving oxygen in conditions such as:

- Respiratory insufficiency associated with acute and chronic lung injury
- Pneumonia
- Acute severe asthma
- Bronchiolitis
- Congenital heart disease associated with increased work of breathing
- Post-extubation
- Obstructive airway disease
- Neuromuscular diseases

6.5. Contra-indication of CPAP

- Conditions with imminent ventilatory support (severe cardio-respiratory compromise and poor respiratory drive)
- Certain congenital malformations of the airway (Choanal atresia / Cleft palate / Tracheo-esophageal fistula/Congenital diaphragmatic hernia)
- Progressive respiratory failure with PCO2>60 mmHg and/or inability to maintain oxygenation (PO2<50 mmHg)

6.6. CPAP delivery system

There are 3 components of a CPAP system: (a) gas source (b) pressure generator and (c) patient interface. **(Annexure VI)**

Gas source	To provide continuous supply of warm humidified and blended gases i.e. air and oxygen
Pressure generator	To create the positive pressure in the circuit. There are different types of CPAP pressure generators like bubble CPAP, ventilator CPAP and flow driver CPAP etc.
Patient interface/ delivery system	To connect the CPAP circuit to the infant's airway. There are various interface used like nasal prongs (single/double or binasal), nasopharyngeal prongs, nasal cannula, nasal masks etc.

List of different patient interface for CPAP:

Patient Interface	Advantage	Disadvantage
Nasal mask	• Minimal nasal trauma	• Adequate seal cannot be obtained
Nasal prongs	• Simple device • Lower resistance leads to greater transmission of pressure	• Difficult to fix • Risk of trauma to nasal septum and turbinates

6.7. Initiation and maintenance of CPAP

Initiation of CPAP	Maintenance of CPAP (How to proceed?)
• **Pressure (PEEP): Start at 5 cm H2O** • **FiO2: 0.3-0.4** • **Flow: 5 L/min**	• Pressure (PEEP): Increase in steps of 1-2 cm H2O to reach a maximum of 8 cm H2O • FIO2: Increase in steps of 0.05 (if oxygenation is still compromised) up to a maximum of 0.8 • Flow: Usually constant

CPAP is considered optimum when the baby on CPAP

- Is comfortable and pink
- Has normal capillary filling time
- Has normal blood pressure
- Has no respiratory distress
- No cyanosis
- Audible air entry on auscultation
- SPO2 within normal range (according to age)
- Optimal chest expansion (Chest Xray in supine: Posterior intercostal space 7-8)

Weaning from CPAP:

Infants clinical condition will guide the speed of weaning

- When baby is haemodynamically stable, with no signs of respiratory distress, adequate lung expansion in chest X-ray, attempts should be taken to wean from CPAP

- Reduce FiO2 in steps of 0.05 to 0.3, and then decrease pressure in steps of 1-2cm H2O until 3-4 cm H2O

*Respiratory distress can be assessed by using Silverman-Anderson score which can be done clinically.

Feature	Score 0	Score 1	Score 2
Chest movement	Equal	Respiratory lag	Seesaw respiration
Intercostal retraction	None	Minimal	Marked
Xiphoid retraction	None	Minimal	Marked
Nasal flaring	None	Minimal	Marked
Expiratory grunting	None	Audible with stethoscope	Audible without stethoscope

[Avery ME, Fletcher BD. The lung and its disorders in the newborn. Philadelphia, W.B. Saunders Company. 1974 (Courtesy of W.A. Silverman)]

Interpretation:

Score: 4-7 = Respiratory distress

Score: >7 = Impending respiratory failure

7. Humidification

Some oxygen delivery methods require use of humidifiers for the patient's comfort. As lack of humidified gas leads to dry nose, dry throat and nasal obstruction.

7.1 Bubble humidifier

Unheated	Unheated bubble humidifiers can be used when oxygen is delivered by cylinders through a nasal catheter.
Heated	Heated humidifiers are more effective than unheated ones however, they are moderately expensive and require a continuous power supply.

7.2. Recommendation

- Humidification is required if oxygen is delivered from a cylinder as it provides cold oxygen. Concentrator provides oxygen at room temperature, so humidification is not required.
- When oxygen is delivered at a standard flow rate (0.5–1 L/min for a neonate, 1–2 L/min for an infant, 1–4 L/min for an older child) through a nasal catheter or nasal prongs, humidification is not necessary.
- Temperature should be set manually/automatically at 37°C.

7.3. Safety of humidifier

A major concern with regard to water humidifiers is bacterial contamination. Humidifiers filled with tap water may be contaminated and can increase the risk of nosocomial infection.

8. Monitoring children while on oxygen therapy

Oxygen administration by any method must be supervised by trained personnel to detect and manage complications appropriately.

8.1. Clinical monitoring:

- Signs of respiratory distress: respiratory rate, chest indrawing
- Any slow or shallow breathing (signs of inadequate ventilation)
- Consciousness level (irritable or drowsy)
- Perfusion - CFT, BP, peripheral pulses, urine output
- Position of nasal prong or catheter (3 hourly check at least)

- Blockage of prongs/catheters with mucus secretion
- Connections are secure for interface
- Any injury at interface site
- Oxygen flow rate
- Abdominal distension especially who is in CPAP
- Settings: FiO2, PEEP and flow

(Chest X-ray to see adequate lung expansion in CPAP and lung condition for other diseases)

8.2. Pulse oximetry monitoring

Sick patients require continuous monitoring with pulse oximetry and can be tested for weaning off oxygen when clinically stable.

If pulse oximeter is inadequate in number, then at least 4 hourly all patients on oxygen support should be monitored and tried for oxygen off.

9. Criteria for stoppage of oxygen

- No signs of respiratory distress
- Baby is haemodynamically stable
- Adequate lung expansion in chest X-ray

*If these conditions are met, then trial of weaning from oxygen should be given daily.

During trial for stopping oxygen:

- Take off the oxygen (unless he or she has severe respiratory distress)
- Monitor the SpO2
- If the SpO2 is > 90% 10–15 min after the child has been taken off oxygen, leave the oxygen off
- Check the SpO2 again in 1 h
- If the SpO2 is < 90%, resume oxygen
- Each day, record the SpO2 and pulse rate on the patient's monitoring chart, and record bedside to determine sufficient supply of oxygen

**Children should not be discharged until their SpO2 has been stable at ≥ 90% while breathing room air for at least 24 h, until all danger signs have resolved and appropriate home treatment can be organized.

(*Supplemental oxygen is best interrupted first in the morning, when there are likely to be adequate staff to observe the child throughout the day. If supplemental oxygen is discontinued in the late afternoon, the presence of few overnight staff and the oxygen desaturation that sometimes occurs during sleep might increase the risk for unrecognized hypoxemia during the night.)*

10. Care of a baby when receiving oxygen

1. Handling	• Gentle handling. • Painful procedure and unnecessary stress should be avoided
2. Airway	
(i) Positioning	• Head raised about 30° with neck support can improve breathing. • Some hypoxic neonates and young infants may be more stable in the prone position, as long as their faces are not obstructed.
(ii) Suctioning	• Assessment of secretions in the nose and mouth. • Suctioning is recommended only when required. • When the secretions are thick, moisten the nares with normal saline or sterile water
3. Fluid and nutrition:	• Withhold oral feeds while the child has severe respiratory distress to avoid the risk of aspiration • Ensure good nutrition as soon as respiratory distress resolves
4. Interface	• Ensure prongs/ catheters are fit snuggly into the nares. • Watch for symmetry of nose, blanching of the skin and any skin break down. • Ensure distance between columella and nasal prongs
5. Cap	• In CPAP, the cap should cover the ears and fit snugly. • Watch for twisting of the nasal interface, blanch the tip of nose and assess for perfusion integrity
6. Oxygen delivery system	• To check whether flow rate is perfect or not in any delivery system. In CPAP, the set pressure (PEEP), FiO2, flow rate needs to look for. • Bubble chamber should be monitored for bubbling and the level of water.
7. Humidifier	• Set temperature of 37°C on the humidifier • Adequate water in the chamber • No condensation in the inspiratory limb and some condensation in the expiratory limb are proof of good and adequate humidification. • The humidification chamber should be set at invasive mode in automatic humidification.
8. Orogastric tube	Pass an orogastric tube and keep the proximal end of tube open. If the infant is being fed while on CPAP, close the tube for half an hour after giving feeds and keep it open for the next 90 minutes (if fed 2hourly)
9. Skin	Watch for color, perfusion, areas of pressure points and areas of skin excoriations

11. Oxygen toxicity

Oxygen toxicity results from exposure to high concentration of oxygen. It has several harmful effect on body. Oxidative damage may occur in any cell of the body but mostly affected systems are as follows:

Body System	Effects of hyperoxia
Central Nervous System	Convulsion, unconsciousness
Respiratory System	Chronic Lung Disease
Eyes	Retinopathy of Prematurity In preterm infants, the retina is often not fully vascularised. Retinopathy of prematurity occurs when the development of the retinal vasculature is arrested and then proceeds abnormally. Associated with the growth of these new vessels is fibrous tissue (scar tissue) that may contract to cause retinal detachment.

12. Infection prevention measures

Besides maintaining aseptic precaution for handling of respiratory equipment, following criteria should be met in all health care facilities:

- There will be IPC committee and IPC guideline in the facility
- All staff will be aware of IPC guideline and instructions will be available at each point of care
- All health care providers will have knowledge on rational use of PPE (personal protective equipment)
- Facility will have designated hand washing areas with water and soap
- There will be adequate hand hygiene supplies (70% alcohol based solutions)
- For respiratory hygiene, masks, disposable tissue will be available for the staff and patients
- Facility will have guidelines and instructions for identifying and managing COVID 19 patients
- Facilities will have environmental cleaning and safe waste management protocol and practice

For different infection prevention measures please see **annexure VII.**

Cleaning of Equipments:

Respiratory equipment	Frequency of cleaning	Disinfectant
Oxygen cylinders	Daily: delivery tubes and masks	Disinfectant (0.5% alcohol)
	Humidifier bottle if used have to disinfect and refill with distilled water	
	Weekly: Cylinder, valve, flow meter	Wet cloth
Oxygen concentrator		Wet cloth soaked with soap
Thorpe tube flow meter	Disconnect all connections before cleaning. Clean and disinfect exterior surfaces of the flow meter daily	Never use lubricant as they are flammable
Humidifiers	Water level should be checked twice daily and topped up as necessary Water in the humidifier should be changed daily Humidifier, water jar, catheter must be washed and disinfected to prevent bacterial colonization*	Soap and water, rinse with clean water and dry in air before use
Nasal Cannula/ catheter/ tubing	These are single use products and should be discarded after each use.	
Pulse oximeter	Wipe after each use	Alcohol swab
CPAP	Always use disposable circuits No need to replace circuit routinely Fill the Humidifier chamber with Distilled water Use Auto-fill option for filling the chamber	Clean the equipment with a soft cloth

*Once a week (for the same patient) and in between patients, all the components of the humidifier should be soaked in a mild antiseptic solution for 30 minutes, rinsed with clean water and dried in air. Allowing the humidifier to dry completely will discourage bacterial colonization

- At every change, check for leakages between the flow meter and humidifier and between the humidifier and oxygen delivery device.
- A spare, clean humidifier filled with clean water should always be available, so that oxygen therapy is not interrupted while the humidifier is being cleaned.

13. Specific areas for neonatal and pediatric oxygen therapy in hospital

In all health facilities, there are designated areas /corners for newborn infants and children, where oxygen can be provided when it is required. These areas are:

- Labor/ Delivery room:
- SCANU: inborn/ outborn/ septic/ step down
- Paediatric ward: conditions causing acute respiratory distress
- Paediatric cardiac ICU
- Paediatric Respiratory unit
- Triage: in emergency ward as well as for suspected COVID 19 newborns and children
- NICU (Neonatal Intensive Care Unit)

These areas should be equipped with following:

For resuscitation:	• Bag and mask (complete set): according to age group appropriate sized mask and bag will be present • Suction device: it may be manual/electrical or central vaccum
For delivery of oxygen:	Oxygen source (cylinders or concentrators or liquid gas) Central piping or tubing for oxygen distribution Regulator, flow meters or flow splitters for regulation and conditioning Delivery interface: prongs/cannula/catheter/ mask etc.
For monitoring of patient's hypoxaemia:	Pulse oximeter

Further Reading

1. Report on Under –five mortality: UNICEF September 2020
2. Wardlaw T, Johansson EW, Hodge M. UNICEF's Division of Communication. New York: WHO Press; 2006. Pneumonia: The Forgotten Killer of Children.
3. Williams BG, Gouws E, Boschi-Pinto C, Bryce J, Dye C. Estimates of world-wide distribution of child deaths from acute respiratory infections. Lancet Infect Dis. 2002;2:25–32)
4. Pneumonia in Children, UNICEF Report, October 2020
5. Duke T, Blaschke AJ, Sialis S, Bonkowsky JL. Hypoxaemia in acute respiratory and non-respiratory illnesses in neonates and children in a developing country. Arch Dis Child. 2002; 86:108–12.
6. Subhi R, Adamson M, Campbell H, Weber M, Smith K, Duke T, et al. The prevalence of hypoxaemia among ill children in developing countries: A systematic review. Lancet Infect Dis. 2009;9:219–27
7. Newborns: Improving survival and well-being: WHO factsheet, September 2020.
8. Oxygen therapy for children. WHO 2016
9. Jahidur Rahman Khan & Nabil Awan. A comprehensive analysis on child mortality and its determinants in Bangladesh using frailty models. Archives of Public Health 2017; 75:58
10. Bangladesh Demographic & Health Survey 2017-1018.
11. Lozano JM. Epidemiology of hypoxaemia in children with acute lower respiratory infection. Int J Tuberc Lung Dis. 2001; 5:496–504.
12. Training module on Integrated Management of Childhood Illness 2019
13. Rojas MX, Granados Rugeles C, CharryAnzola LP. Oxygen therapy for lower respiratory tract infections in children between 3 months and 15 years of age. Cochrane Database Syst Rev 2009; CD005975.
14. Pocket book of hospital care for children: guidelines for the management of common childhood illnesses. 2nd edition. Geneva: World Health Organization; 2013.
15. Yee W, Chen SY, Singhal N. Oxygen saturation trends immediately after birth. J Pediatr 2006; 148:590–594.
16. Singapore Neonatal Resuscitation Guidelines 2016
17. SUPPORT Study Group of the Eunice Kennedy Shriver NICHD Neonatal Research Network. Target ranges of oxygen saturation in extremely preterm infants. N Engl J Med 2010; 362:1959–1969.

18. Management Protocol of Newborn. Department of Neonatology. Bangabandhu Sheikh Mujib Medical University 2016

19. Anne Greenough, Anthony D Milner. Acute Respiratory Disease in Janet M Rennie. Editor. Rennie & Roberton's text book of Neonatology, 5th edition. Churchill Livingstone. 2012; 27:468 -484.

20. Kattwinkel J, Niermeyer S, Nadkarni V, Tibballs J, Phillips B, Zideman D, et al. ILCOR advisory statement: resuscitation of the newly born infant. Pediatrics 1999;103: e56.

21. WHO-UNICEF technical specifications and guidance for oxygen therapy devices 2019.

22. Frey B, Shann F. Oxygen administration in infants. Arch Dis Child Fetal Neonatal Ed 2003; 88:F84–F88.

23. WHO. Oxygen therapy for children; 2016; p. 27.

24. Protocol for administering continuous positive airway pressure. The Indian Journal of Pediatrics. June 2008

25. Wilson PT, Morris MC, Biagas KV, Otupiri E, Moresky RT. A randomized clinical trial evaluating nasal continuous positive airway pressure for acute respiratory distress in a developing country. J Pediatr 2013; 162:988–992

26. Duke T. CPAP: a guide for clinicians in developing countries. Paediatr Int Child Health 2014; 34:3–11.

27. Fedor KL. Non – invasive Respiratory support in infants and children. Respir Care 2017; 62 (6): 699-717.

28. Cheifetz IM. Invasive and noninvasive pediatric mechanical ventilation. Respir Care 2003; 48(4):442-458; discussion 453-458.

29. Deorari AK, Thukral A. Continuous positive airway pressure. In: Walsh BK, editor. Neonatal and pediatric respiratory care, 4th edition. St Louis, Missouri: Elsevier; 2015:267-286.

30. Teague GW, Thompson-Batt D. Noninvasive mechanical ventilation of the infant and children. In: Walsh BK, editor. Neonatal and pediatric respiratory care, 4th edition. St Louis, Missouri: Elsevier; 2015:287- 299.

31. Martin S, Duke T, Davis P. Efficacy and safety of bubble CPAP in neonatal care in low and middle income countries: a systematic review. Arch Dis Child FFetal Neonatal Ed 2014; 99:495–504.

32. Van den Heuvel M, Blencowe H, Mittermayer K, Rylance S, Couperus A, Heikens GT et al. Introduction of bubble CPAP in a teaching hospital in Malawi. Ann Trop Paediatr 2012; 31:59–65.

33. Chisti MJ, Salam MA, Smith JH, Ahmed T, Pietroni MC, Shahunja KM, et al. Bubble continuous positive airway pressure for children with severe pneumonia and hypoxaemia in Bangladesh: an open, randomised controlled trial. Lancet 2015; 386; 1057–1065.

34. Tagare A, Kadam S, Vaidya U, Pandit A, Patole S. Bubble CPAP versus ventilator CPAP in preterm neonates with early onset respiratory distress – a randomised controlled trial. J Trop Paediatr 2013; 59:113–119.

35. McKiernan C, Chua LC, Visintainer PF, Allen H. High flow nasal cannuae therapy in infants with bronchiolitis. J Pediatr 2010; 156:634–638.

36. Spentzas T, Minarik M, Patters AB, Vinson B, Stidham G. Children with respiratory distress treated with highflow nasal cannula. J Intensive Care 2009; 24:323–328.

37. Hilliard TN, Archer N, Laura H, Heraghty J, Cottis H, Mills K, et al. Pilot study of vapotherm oxygen delivery in moderately severe bronchiolitis. Arch Dis Childh 2011; 97:183.

38. Lampland AL, Plumm B, Meyers PA, Worwa CT, Mammel MC. Observational study of humidified highflow nasal cannula compared with nasal continuous positive airway pressure. J Pediatr 2009; 154:177–182.

39. Weber MW, Palmer A, Oparaugo A, Mulholland EK. Comparison of nasal prongs and nasopharyngeal catheter for the delivery of oxygen in children with hypoxaemia because of lower respiratory tract infection. J Pediatr 1995; 127:378– 383.

40. Randerath WJ, Meier J, Genger H, Domanski U, Ruhle KH. Efficiency of cold passover and heated humidification under continuous positive airway pressure. Eur Respir J 2002; 20:183–186.

41. Duke T, Frank D, Mgone J. Hypoxaemia in children with severe pneumonia in Papua New Guinea. Int J Tuberc Lung Dis 2000; 5:511–519.

42. PK Rajib. CPAP: Bedside Application in the newborn. 2nd edition. New Delhi 2011

Campbell EJ, Baker D, CritesSilver P. Subjective effects of humidification of oxygen for delivery by nasal cannula. Chest 1988; 93:289–293.

43. Kuluz JW, McLaughlin GE, Gelman B, Cantwell P, Thomas J, Mahon T, et al. The fraction of inspired oxygen in infants receiving oxygen via nasal cannula often exceeds safe levels. Respir Care 2001; 46:897–901.

44. Ammari A, Kashlan F, Ezzedeen F, Al-Zahrani A, Kawas J, Saidan M. Bubble nasal CPAP Manual 2005.

45. Prathik BH, Tapash B, Vikram D. Oxygen Therapy Review. Journal of Neonatology 2013; 27 (2): 9-14.

46. Gupta N, Saini SS, Murki S, Kumar P, Deorari A. Continuous Positive Airway Pressure in preterm neonates: An update of current evidence and implications for developing countries. Indian Pediatr 2015; 52: 319-328.

Annexure-1

Pulse Oximeter

A pulse oximeter can provide vital information about a sick child. It is the best instrument for determining whether a child needs oxygen, although clinical signs of hypoxaemia and severe illness should also be sought.

A pulse oximeter consists of the monitor containing the batteries and display, and the probe that senses the pulse**.**

Pulse oximeter monitor:

The monitor contains the microprocessor and display. The display shows the oxygen saturation, the pulse rate and the waveform detected by the sensor. The monitor is connected to the patient via the probe. During use, the monitor updates its calculations regularly to give an immediate reading of oxygen saturation and pulse rate. The pulse indicator is continuously displayed to give information about the circulation. The audible beep changes pitch with the value of oxygen saturation and is an important safety feature. The pitch drops as the saturation falls and rises as it recovers. This allows you to hear changes in the oxygen saturation immediately, without having to look at the monitor all the time.

Pulse Oximeter probe:

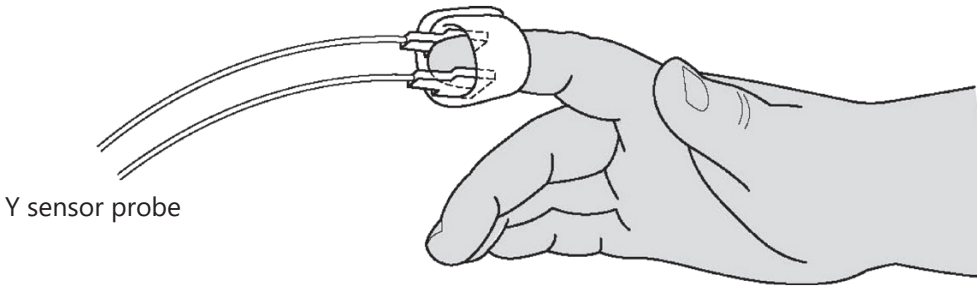
The oximeter probe consists of two parts, the light emitting diodes (LEDs) and a light detector (called a photo-detector). Probes are designed for use on the finger, toe or ear lobe. They are of different types. Ear probes are lightweight and are useful in children or if the patient is very vasoconstricted. Small probes have been designed for children but an adult hinged probe may be used on the thumb or big toe of a child. For finger or toe probes, the manufacturer marks the correct orientation of the nail bed on the probe. The probe connects to the oximeter using a connector with a series of very fine pins.

Indication:

- All children at the time of admission (not just those with pneumonia);
- To see the progress of children during ward rounds and nursing observations who deteriorates, with respiratory distress, apnoea or decreased consciousness.

Sensor probe for neonates and young infants:

This is "Ysensor" digital probe, that require some form of attachment to the hand, foot, toe or finger. They can be ideal for neonates and young children and can be attached to the foot or hand of very lowbirthweight neonates. Some probes are designed to be attached to the ear lobe, but they are generally less useful for a range of ages or for spot checks and daily monitoring.



Y sensor probe

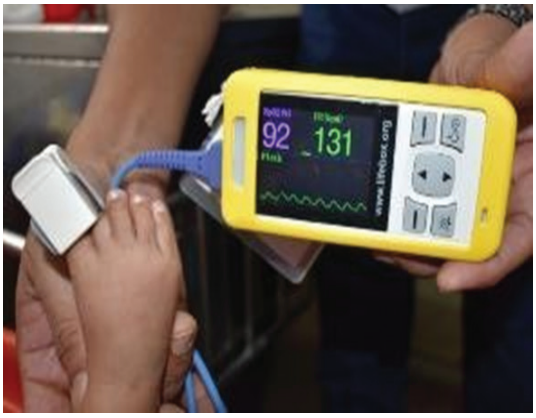
The probes and connecting cables are delicate and are easily damaged if stepped on. Cables break more frequently as the pulse oximeters age. Finger clipon sensors last about 6 months on average and can be used on many children during this time. It is important always to have a spare probe available in case one fails.

Steps of using pulse oximeter:

Step 1: Ensure the pulse oximeter is well charged. Connect the probe to the pulse oximeter.

Step 2: Select the appropriate probe with particular attention to correct sizing and where it will go (usually finger, toe or ear). Turn the pulse oximeter on. Always make sure the alarms are on.

Step 3: The probe emits a red light when the machine is switched on; check that you can see this light to make sure the probe is working properly.



Step 4: Ask the mother to calm the baby. If used on a finger or toe, make sure the area is clean and well exposed.

Step 5: Put the probe in the toe and position the probe carefully; make sure it fits easily without being too loose or too tight.

Step 6: Allow several seconds for the pulse oximeter to detect the pulse and calculate the oxygen saturation. Once the unit has detected a good pulse, the oxygen saturation and pulse rate will be displayed. Look for the displayed pulse indicator that shows that the machine has detected a pulse. Without a pulse signal, any readings are meaningless.

Step 7: If reading is taken from the thumb, avoid the arm being used for blood pressure monitoring as cuff inflation will interrupt the pulse oximeter signal.

If no signal is obtained on the oximeter after the probe has been placed on a finger, check the following:

- Is the probe working and correctly positioned? Try another location.
- Does the patient have poor perfusion?
- Check the temperature of the patient. If the patient or the limb is cold, gentle rubbing of the digit or ear lobe may restore a signal.

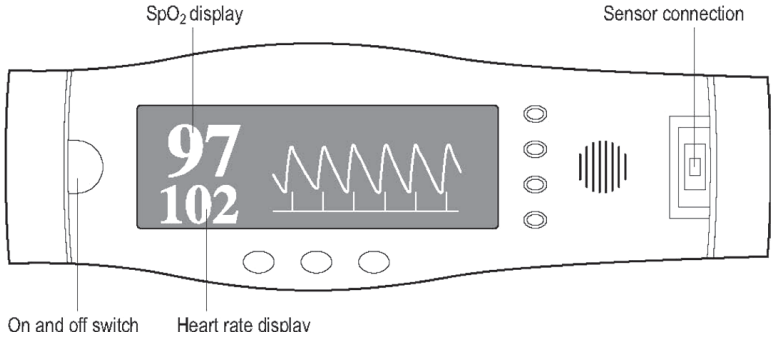
The alarms are as follows:

- Low saturation emergency (hypoxia) SpO2 <90%
- No pulse detected
- Low pulse rate
- High pulse rate

Displays:

Examples of pulse oximeter displays showing normal and abnormal readings are given below:

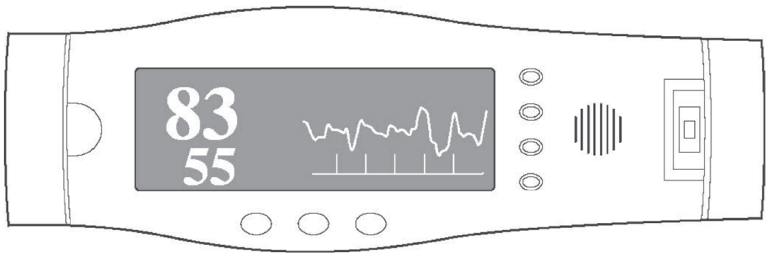
Figure (i) shows a pulse oximeter with a normal reading (pulse rate = 102 beats/min; SpO2 = 97%) and a plethysmographic (pulse) wave indicating a good arterial trace and a valid reading.



(i) Pulse oximeter showing a normal reading

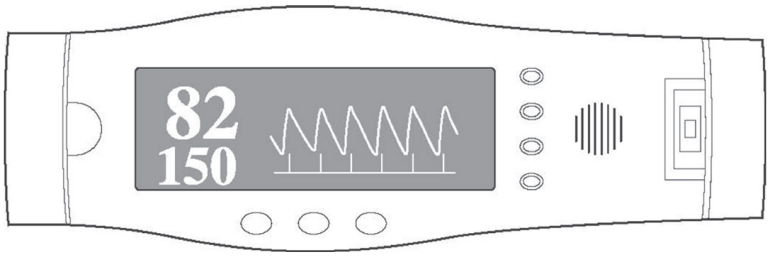
Figure (ii) shows an abnormal reading (pulse rate = 55 beats/min; SpO2 = 83%). In this case, the plethysmographic (pulse) wave is uneven, indicating a poor arterial trace. The accuracy

of the heart rate reading should be checked by comparing the number on the pulse oximeter display with auscultation of the heart and counting the true beats. A poor pulse waveform on the pulse oximeter, as in this case, is usually due to inadequate attachment of the sensor probe to the skin, especially on an active child, or to poor peripheral perfusion. This SpO2 reading is not valid, and the probe should be repositioned.



(ii) Pulse oximeter showing a poor Plethysmographic (pulse) wave

In figure iii (pulse rate = 150 beats/min; SpO2 = 82%), the pulse oximeter has a good plethysmographic wave, indicating a valid arterial trace. Therefore, the SpO2 reading, which is abnormally low (82%), is accurate and indicates that the patient is hypox aemic. Oxygen should be given. Note the increased heart rate, which is common in seriously ill patients.



(iii) Pulse oximeter showing good plethysmographic (pulse) wave with low oxygen saturation

Planning discharge

If the child is well, and the SpO2 has been stably > 90% off oxygen for 12–24 h, and the parents understand how to provide home care and when to return, it is safe to send the child home.

Care of a pulse oximeter:

1. Keep the battery fully charged
2. When the probe gets dirty, clean it gently with a damp cloth or alcohol swab (preferably after each use)
3. Position safely to avoid dropping or damage from spillages
4. Insert the plug or the lead correctly to avoid damage. Always look at the shape of the lead before inserting
5. Disconnect the probe carefully holding it firmly
6. When disconnecting the probe, grip the cable firmly and not the cable
7. When not in use, always coil the lead and position the probe where it cannot be damaged.

Annexure-II

IMCI Classification of Pneumonia

(a) Age: 2 months up to 5 years

SIGNS	CLASSIFY	IDENTIFY TREATMENT (Urgent pre-referral treatments are in bold print)
• Any general danger sign or • Stridor in calm child or • Oxygen saturation (SpO_2) <90%	*Pink:* SEVERE PNEUMONIA OR VERY SEVERE DISEASE	➢ **Give first dose of intramuscular Gentamicin and first dose of oral Amoxicillin** ➢ **Refer URGENTLY to hospital** ➢ **Give Diazepam if convulsing now** ➢ **Give inhaled Salbutamol if wheezing**
• Chest indrawing or • Fast breathing	*Yellow:* PNEUMONIA	➢ **Give oral Amoxicillin for 5 days** ➢ If wheezing (or disappeared after inhaler Salbutamol) give an inhaler Salbutamol for 5 days ➢ Soothe the throat and relieve the cough with a safe remedy ➢ If coughing for more than 14 days or recurrent wheeze, **refer** for possible TB or asthma assessment ➢ Advise mother when to return immediately ➢ Follow-up in 3 days
• No signs of pneumonia or very severe disease	*Green:* COUGH OR COLD	➢ If wheezing (or disappeared after inhaler Salbutamol) give an inhaled Salbutamol for 5 days ➢ Soothe the throat and relieve the cough with a safe remedy ➢ If coughing for more than 14 days or recurrent wheezing, **refer** for possible TB or asthma assessment ➢ Advise mother when to return immediately ➢ Follow-up in 5 days if not improving

(b) Age: 0-2 months

SIGNS	CLASSIFY AS	IDENTIFY TREATMENT (Urgent pre-referral treatments are in bold print)
Any one or more of the following signs: • Unconsciousness/drowsy • Convulsion or H/O Convulsion • Unable to feed • Persistent Vomiting • Bulging fontanels • Apnoea • Central Cyanosis • Major Bleeding • Weight < 1500 gm • Major congenital malformation • Surgical condition requiring hospitalization	*Pink:* **POSSIBLE SERIOUS BACTERIAL INFECTION or VERY SEVERE DISEASE- CRITICAL ILLNESS (VSD-CI)**	**➢ Give first dose of intramuscular Gentamicin and first dose of oral Amoxicillin** **➢ Treat to prevent low blood sugar** **➢ Advise mother how to keep the infant warm on the way to the hospital** **➢ Refer URGENTLY to hospital**
Any one or more of the following signs • Severe chest indrawing • Fever (37.5°C* or above) or low body temperature (less than 35.5°C*) • Not feeding well • Movement only when stimulated/ no movement at all	*Pink:* **POSSIBLE SERIOUS BACTERIAL INFECTION or VERY SEVERE DISEASE- CLINICAL SEVERE INFECTION (VSD-CSI)**	**➢ Give first dose of intramuscular Gentamicin and first dose of oral Amoxicillin** **➢ Treat to prevent low blood sugar** **➢ Advise mother how to keep the infant warm on the way to the hospital** **➢ Refer URGENTLY to hospital** **➢ If referral is REFUSED or NOT FEASIBLE, continue intramuscular Gentamicin for 2 days and oral Amoxicillin for 7 days** **➢ Follow up in 4 days**
• Fast breathing (60 breaths per minute or more) for age 0-6 days	*Pink:* **POSSIBLE SERIOUS BACTERIAL INFECTION or VERY SEVERE DISEASE- FAST BREATHING PNEUMONIA (0-6 DAYS)**	**➢ Give first dose of oral Amoxicillin** **➢ Treat to prevent low blood sugar** **➢ Advise mother how to keep the infant warm on the way to the hospital** **➢ Refer URGENTLY to hospital** **➢ If referral is REFUSED or NOT FEASIBLE, continue oral Amoxicillin for 7 days** **➢ Follow up in 4 days**
• Fast breathing (60 breaths per minute or more) for age 7-59 days	*Yellow:* **FAST BREATHING PNEUMONIA (7-59 DAYS)**	➢ Give oral Amoxicillin for 7 days ➢ Treat to prevent low blood sugar ➢ Follow up in 3 days
• Umbilicus red or draining pus • Skin pustules	*Yellow:* **LOCAL BACTERIAL INFECTION**	➢ Give oral Amoxicillin for 5 days ➢ Teach mother to treat local skin infections at home ➢ Advise mother to give home care ➢ Follow up in 2 days
• None of the signs of very severe	*Green:* **INFECTION UNLIKELY**	➢ Advise mother to give home care for the young infant

Annexure-III

(a) Oxygen Concentrator

Oxygen concentrators:

Oxygen concentrators are machines that extract nitrogen from atmospheric air, resulting in an output of almost pure oxygen. They require a continuous, reliable power source, such as mains electricity plus a backup generator or oxygen cylinder in case of power failure.

Steps of using an oxygen concentrator:

1. Position the concentrator so that it is at least 30 cm away from walls or curtains, so that the inlet at the back is not obstructed.
2. Connect oxygen tubing to the flow splitter or oxygen outlet.
3. Plug the power cord into the mains electricity supply.
4. Turn on the concentrator (switch on the console). A green light should come on when a sufficiently high oxygen concentration is reached, usually within 10 min.
5. Adjust the flow meter to the flow required for the patient or, if using a flow splitter, the number of patients receiving oxygen.

Giving oxygen

Oxygen is usually given through a nasal catheter or nasal prongs.

Nasal catheter: Set a flow rate of 0.5 L/min for neonates or 1–2 L/min for infants and older children. Humidification is not required with a nasal catheter if these flow rates are used. Catheters should be removed and cleaned twice a day, as they can become blocked with mucus.

Nasal prongs: Set a flow rate of 0.5–1 L/min for neonates, 1–2 L/min for infants and older children and up to a maximum of 4 L/min for preschool and schoolaged children. Humidification is not required with nasal prongs as long as these flow rates are used. Oxygen prongs are more expensive than oxygen catheters, but they can be reused if they are carefully soaked in clean, warm soapy water, followed by dilute bleach, rinsing in water and careful drying.

Monitoring:

After starting a child on oxygen, recheck the oxygen saturation with a pulse oxi meter or check for signs of hypoxaemia.

If, after starting on oxygen, the child still has an SpO2 < 90% or has cyanosis or severe chest indrawing, increase the oxygen flow to a maximum of 2 L/min for an infant or up to 4 L/min for an older child. If, despite this, the child still has signs of hypoxaemia, check that:

- the concentrator is delivering a flow of gas;
- the light indicating an adequate concentration of oxygen is on and that no other alarms are on;
- oxygen is flowing from the catheter or prongs (put the end under water in a beaker and watch for bubbles, or hold the end close to your hand to feel the airflow);
- there are no leaks in the connections or the oxygen tubing; and
- the child's nose is not blocked

Precaution:

Do not use flow rates > 2 L/min for neonates or infants, as they can result in distension of the stomach. Any infant who is unable to suck or who needs an oxygen flow of 2 L/min should have a nasogastric tube to decompress the stomach.

Maintenance:

- The filter (at the back of portable models to stop dust and other airborne particles from entering the unit) should be removed and cleaned once weekly in warm soapy water, dried with an absorbent towel and replaced.
- The exterior of the oxygen concentrator should be cleaned once in a week with a mild disinfecting cleaning agent or a diluted solution of bleach (5.25% sodium hypochlorite). A solution of 1:100 to 1:10 of bleach to water can be used, depending on the amount of organic material present. Allow the solution to remain on the surface for 10 min, and then rinse off and dry.

Annexure-III

(b) Oxygen cylinder

Oxygen cylinders

Cylinders contain compressed gaseous oxygen. They must have a regulator to limit the pressure of oxygen being released, a gauge to indicate the amount of oxygen in the cylinder and a flow meter to control oxygen flow to the patient.

Steps of using oxygen cylinder:

- Tighten all the connections (between the cylinder and the regulator and between the regulator and the flow meter), so that oxygen does not leak out.
- Open the regulator, and check the amount of oxygen in the cylinder on the pressure gauge. If the needle of the gauge is in the red zone, the cylinder is nearly empty and should not be used, unless it is the only one you have. *Never* allow such a cylinder to be used for a child overnight, as it will run out and the child will become hypoxaemic.

Giving oxygen:

Oxygen is usually given by nasal catheter or nasal prongs.

Monitoring:

After starting a child on oxygen, recheck the oxygen saturation with a pulse oximeter and/ or check for signs of hypoxaemia. If the child still has an SpO2 < 90% or has cyanosis or severe chest indrawing, increase the oxygen flow to a maximum of 2 L/min for an infant or up to 4 L/min for an older child. If, despite this, the child still has signs of hypoxaemia, check that:

- The cylinder has sufficient oxygen
- Oxygen is flowing from the catheter or prongs (put the end under water in a beaker and look for bubbles, or hold the end close to your hand to feel the airflow);
- There are no leaks in the connections or the oxygen tubing; and
- Child's nose is not blocked.

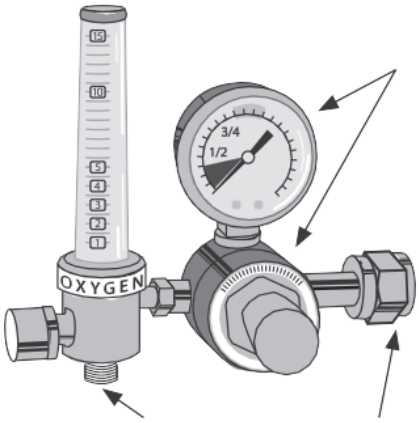
Precaution: Do not use flow rates > 2 L/min for neonates or infants, as they can result in distension of the stomach. Any infant who is unable to suck or who needs an oxygen flow of 2 L/ min should have a nasogastric tube to decompress the stomach.

Maintenance:

Weekly cleaning of the cylinder with damp cloth

Annexure-IV

Thorpe Flow Meter



This variable orifice flowmeter consists of a connection to a gas source, a distal valve to control gas flow rate, an upright clear tube containing a float (which rises and falls in relation to gas flow) and an outlet port.

Thorpe tube flow meters are calibrated to a specific medical gas (e.g. oxygen or medical air) and come in dedicated flow rate ranges appropriate for different patient groups (e.g. neonate, infant, child, adult)

For neonatal applications, especially with premature babies, flows as low as 20–30 mL/min may be required.

Typical flow range with their clinical application:

Example flow ranges	Clinical application
0-1 L/min	Ultra low flow applications for neonatal care
0-3 L/min	Low flow applications for neonatal and paediatric care
0-5 L/min	Low to medium flow for paediatric O2 therapy
0-15 L/min	For low to high flow applicants

Precaution:

Never use lubricants for cleaning as flammable.

Annexure-V

Oxygen delivery devices

(a) Nasal Prongs:

Nasal prongs are a device that ends in two short tapered tubes (about 1 cm in length) designed to lie just within the nostrils. They are also called nasal cannulae.

Practical considerations:

- The distal prong should fit well into the nostril (premature infants: 1 mm, infants weighing up to 10 kg: 2 mm).
- The prongs should be secured with a piece of tape on the cheeks near the nose.

Flow rates: 0.5–1 L/min for neonates, 1–2 L/min for infants, 1–4 L/min for older children.

Advantage:

-There is no risk of gastric distension at standard flow rates, as they cannot be inserted too far into the nasal passage.

-Humidification is not required with standard oxygen flow rates, as the natural nasal mechanisms heat and humidify the inspired oxygen.

Disadvantages:

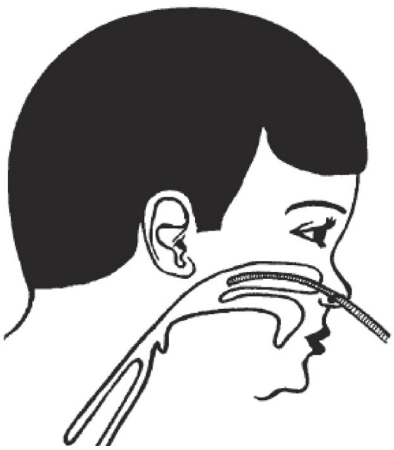
The airway will become obstructed by mucus, especially if a high flow with no humidification is used.

(b) Nasal catheter

A nasal catheter is a thin, flexible tube that is passed into the nose and ends with its tip in the nasal cavity.

Practical consideration:

- In neonates and infants, 8-French (F) size catheters should be used. A catheter passed for a distance equal to the distance from the side of the nostril to the inner margin of the eyebrow usually reaches the posterior part of the nasal cavity. In infants, this is about 2.5 cm.
- The tip of the catheter should **not** be visible below the uvula. A catheter is easily secured with tape above the upper lip.
- The maximum flow rate should be set at 0.5–1 L/min for neonates and 1–2 L/min for infants and older children.



Advantages:

- Nasal catheters are usually well tolerated, and they are unlikely to be dislodged.
- The oxygen does not have to be humidified because the tip of the catheter lies in the nasal cavity.

Disadvantages:

Catheters can become blocked with mucus, which can cause upper airway obstruction. There is little risk of displacement into the oesophagus, with a consequent risk of gastric distension.

(c) Head box/ incubators/tents/face masks

Advantages:

- With oxygen piped into a head box, incubator or tent, the actual FiO2 can be determined precisely with an oxygen analyser placed near the infant's mouth.
- There is no increased risk for airway obstruction by mucus or of gastric distension, and humidification is not necessary.

Disadvantages:

- Carbon dioxide toxicity can occur if the flow of oxygen is inadequate. This can result from setting the oxygen flow too low or from kinking or disconnection of the oxygen tubing
- When a head box is used with an inappropriately tight seal around the infant's neck, carbon dioxide can be retained. A gas flow of 2–3 L/kg per min is necessary to avoid rebreathing of carbon dioxide in a head box.
- Head boxes, facemasks, incubators and tents all require high oxygen flows to achieve adequate concentrations of oxygen and avoid carbon dioxide accumulation, and they are therefore expensive and wasteful.
- Head boxes and facemasks also interfere with feeding.

Annexure-VI

Steps of Initiation and Nursing Care during CPAP

Setting of a Bubble CPAP:[31-33]

Step 1: Assemble the machine, circuit, distilled water bottles, gloves, cloths and antiseptic solutions

Step 2: Clean the machine, temperature probe and heater wire

Step 3: Connect the blender to compressed air and compressed oxygen sources

Step 4: Fix the water chamber available in the disposable circuit kit to the humidifier. Fill the water chamber with distilled water.

Step 5: Fix the bubble chamber to the slot on the CPAP machine. Fill it with distilled water. Ensure this is below the level of patient.

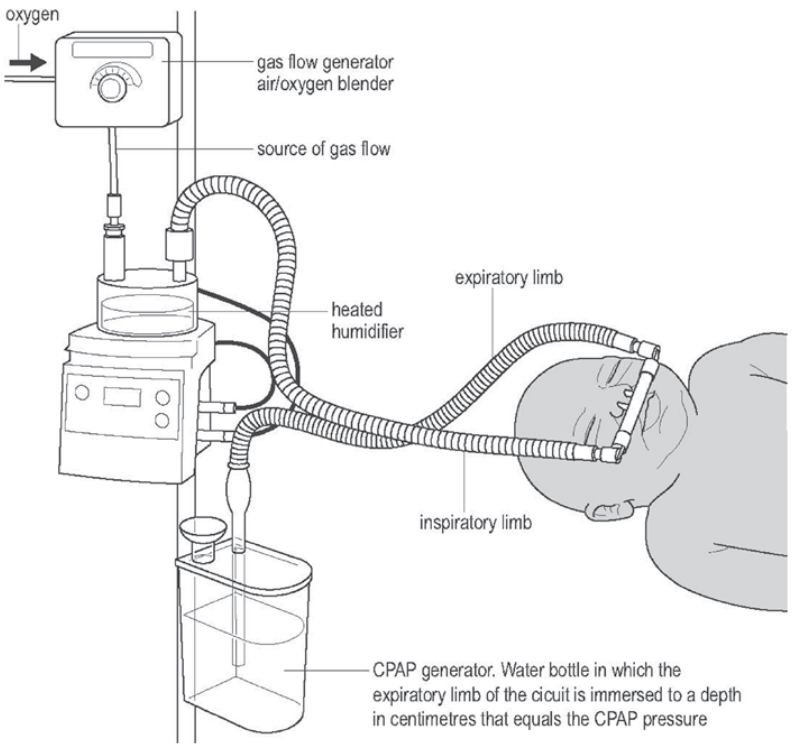
Step 6: Identify the safety device- the blue inspiratory limb and white expiratory limb.

Step 7: Fix the safety device to the water chamber and to the oxygen tube from the blender

Step 8: Fix the inspiratory limb to the water chamber

Step 9: Lock the white expiratory to the blue inspiratory limb

Step 10: Connect the other end of expiratory limb to the bubble chamber



Bubble CPAP circuit connected to an infant by close fitting nasal prongs

Step 11: Fix the heater wire at appropriate slots in the humidifier and in the inspiratory limb

Step 12: Fix the temperature probe to the appropriate slot on the humidifier and the two slots in the blue inspiratory limb

Step 13: Switch on the humidifier and set it in invasive mode only

Step 14: Set the appropriate flow, FiO2 and pressure

Step 15: Wait for the temperature display to reach 37 degree before connecting to the patient.

Then occlude the patient end of the circuit with your palm and observe if:

a. Bubbling occurs in the water chamber - If there are no bubbles, look for any leak in the circuit; if no leak is found, increase the flow by 1 L/min and re-check.

b. The set pressure is delivered (see the manometer reading) - If it is less than the set pressure, look for any leaks in the circuit/around the cannula. If no leak is found, increase the flow and recheck

**Inspiratory limb is

- From the flow meter to the humidifier and
- From the humidifier to the patient end (e.g. nasal cannula)

**Expiratory limb - from the patient end to a chamber filled with sterile water

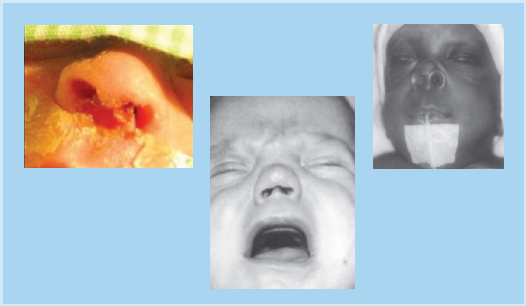
Initiation of CPAP

- Place a roll under infants' shoulder to slightly extend the neck
- Application of prongs:
- Choose the correct size prong (the prongs should fill the nasal opening without stretching the skin)
- Apply a thin strip of *Tegaderm* on overlying skin of septum
- Place the prongs with the curve downwards and fix
- Attach the patient end of the ventilator circuit to the cannula
- Attach a pulse-oximeter to the infant

Checklist for Nursing Care

- Monitor the infant frequently, observe if the baby is comfortable
- Pass an orogastric tube. Keep the proximal end of tube open. If the infant is being fed while on CPAP, close the tube for half an hour after giving feeds and keep it open for the next 90 minutes (if fed 2hourly).
- Do regular but gentle nasal suction to clear the mucus 4 hourly or as and when required.
- Clean the nasal cannula and check its patency once per shift.
- Change the infant's position regularly every 2-4 hours and check the skin condition frequently for redness and sore

Complications of CPAP Therapy:

Patient related	Equipment related
(A) Local: **Nasal:** • Nasal septal damage due to in-appropriate size and softness of nasal prongs • Nasal irritation, damage to nasal septum, nasal bleeding, columellar necrosis (rarely)  **(B) Systemic:** • Air leak (pneumothorax) • Impaired cardiac output and decrease urine output • Gastric distension	• Obstruction of nasal prongs from mucus plugging or kinking of nasopharyngeal tube • Inactivation of airway pressure alarms • Insufficient or excessive gas flow may lead to increase work of breathing and over-distension of lungs respectively.

Humidified high flow through nasal prongs:

- Highflow CPAP through nasal prongs is a promising method for providing additional respiratory support in hospitals that do not have mechanical ventilators or standard bubble CPAP machines.
- It delivers CPAP to neonates with a high gas flow (up to 2 L/kg body weight per min) through normal nasal prongs.[34]This rate delivers 4–5 cm H20 of PEEP.
- Higher flows through nasal prongs of an air–oxygen mix with humidification have been used for preterm neonates and infants with very severe pneumonia or bronchiolitis who are failing to respond to standard oxygen flow rates or when ventilation is inadequate.[35-38]

Benefits:

- Highflow CPAP may help to increase lung volume, reduce atelectasis (alveolar and lung segmental collapse) and stimulate breathing in infants with apnoea.
- Low cost method

Limitations:

- It requires special equipment – a source of gas flow, an oxygen blender and a humidifier.
- This method requires highly effective humidification to prevent drying of the nasal mucosa, to avoid bleeding and nasal obstruction.
- It requires careful monitoring of ventilation as high flow 100% oxygen can maintain SpO2 in the normal range despite dangerous hypercarbia and near respiratory failure.

Annexure-VII

Maintenance & trouble shooting of equipments

Maintenance of Equipment:

Oxygen Cylinder:

Schedule period	Activities	Check
Daily	Cleaning	Ensure delivery tubes and masks are decontaminated. If humidifier bottle is used, disinfect and refill with clean water
	Visual checks	Check cylinder is correct type and correctly labelled Check all parts are fitted tightly and correctly
	Function	Before use, ensure cylinder has sufficient pressure Ensure flow is sufficient for intended use Close cylinder valve after each use
Weekly	Cleaning	Clean cylinder, valve and flow meter with damp cloth
	Visual checks	Check for leakage: hissing sound or reduction in pressure
	Function	Remove valve dust with brief, fast oxygen flow checks

Source: Adapted from *User care of medical equipment: a first line maintenance guide for end users. Strengthening Specialised Clinical Services in the Pacific;* 2015 (https://bmet.ewh.org/handle/20.500.12091/83, accessed 26 April 2019)

Thorpe tube flow meter:

- Disconnect all connections before cleaning
- Clean and disinfect exterior surface of the flow meter according to the manufacturers instruction and infection prevention control (IPC) protocol specific to the setting
- Never use lubricants as they are flammable
- A trained biomedical engineer or technician should perform regular inspections and calibration checks with an oxygen flow analyzer.

Bubble Humidifiers:

- The water level in the humidifier should be checked twice daily and topped up as necessary
- Humidifier equipment must be washed and disinfected regularly to prevent bacterial colonization.

- The water in the humidifier should be changed daily
- Humidifier, water jar and catheter should be washed in mild soapy water, rinsed with clean water and dried in air before reuse.
- All components of humidifier should be soaked in a mild anti-septic solution for 30 minutes, rinsed with clean water and dried in air
- A spare, clean humidifier filled with clean water should always be available, so that oxygen therapy is not interrupted while the humidifier is being cleaned.

Nasal cannula, catheter, oxygen tubing:

- These are single used products and should be disposed of after each patient.

Pulse Oximeter:

Schedule period	Activities	Check
Daily	Cleaning	- Clean and disinfect exterior surface of the pulse oximeter according to the manufacturers instruction and infection prevention control (IPC) protocol specific to the setting - Clean and disinfect the probe after each use according to manufacturer's instruction and infection prevention control (IPC) protocol specific to the setting -Discard single-use probes after each use
	Visual checks	- Check all parts are present and connected - Ensure that probes which are not in use, are not left hanging, or lying about where they can be damaged - Check cables are not twisted and remove from service if any damage is visible
	Function	-Check operation on healthy subject if in doubt of function
Weekly	Cleaning	- Unplug, remove equipment cover, clean and disinfect exterior surface manufacturers instruction and infection prevention control (IPC) protocol specific to the setting - Replace cover
	Visual checks	- Tighten any loose screw and check parts are fitted tightly. If plug, cable or sockets are damaged, replace those
	Function	- Check operation of all lights, indicators and visual displays. - Check probe disconnection alarm
Every 6 months		Biomedical engineer unit preventive maintenance check required

CPAP:

Circuit/ Bubbler:
Blended air/ O2 gas supply
Air flow between 5-10 L/min
Correct humidifier temperature (36.8° - 37.3° C)
Water present in humidifier bottle up to the specified mark
Corrugated tubings correctly placed
Gas bubbling continuously
Water level at 5 cm H20
Interface:
Nasal prongs: correct size and position
Chin strap: correct size and position
Nasal septum intact or not
Position:
Head and neck position correct (can be used neck roll if supine or side position of infant)

Trouble shooting:

Oxygen cylinder:

Problem/fault	Possible cause	Solution
No oxygen is flowing	• Empty cylinder.	• Replace cylinder
	• Flow meter knob or cylinder flow valve is closed	• Open valves, and then check meter registers flow
	• Faulty regulator	• Close all valves and replace regulator
Leakage from cylinder or flow meter	• Cylinder is not connected to pressure regulator properly	• Tighten all fittings
	• Faulty or missing washer between regulator and cylinder	• Replace washer
	• Flow meter seal damaged or loose	• Replace sealing washer and re-align flow meter
	• Cylinder faulty	• Label faulty and take appropriate action
Leakage cannot be located	• Leakage too small to be heard.	• Apply detergent solution (not oily soap) to joints. Bubbles will show at leak point • Clean/ replace washer and tighten at that point
Flow meter ball not moving, yet oxygen is flowing	• Faulty flow meter	• Close all valves, disconnect flow meter and clean inside. Reconnect and test • If problem persists, replace flow meter
Pressure gauge does not show pressure, yet oxygen is flowing	• Faulty pressure gauge	• Replace pressure gauge

Thorpe tube flow meter:

Problem/fault	Possible cause	Solution
No oxygen is flowing	Flow meter knob or cylinder flow valve is closed	• Open valves, and then check meter registers flow
Leakage from cylinder or flow meter	Flow meter seal damaged or loose	• Checks for leaks at the connection between the flow meter and the oxygen source, at the connection between the oxygen flow meter and the oxygen delivery device, and along the oxygen delivery device to the patient • If leak occurs at the regulator, try tightening the connection • If leak occurs at the terminal unit, try another flow meter. If a different flow meter still leaks, the leak is probably at the terminal unit
Leakage cannot be located	Leakage too small to be heard	• Apply detergent solution (NOT oily soap) to joints. Bubbles will show at leak point • Clean/replace washer and tighten at that joint
Flow meter ball not moving, yet oxygen is flowing	Faulty flow meter	• Close all valves, disconnect flow meter and clean inside. Reconnect and test. • If problem persists, replace flow meter
Flow meter fails to deliver expected flow or behaves erratically	Faulty flow meter	• Check the output with a calibrated flow analyser • If necessary, send it for repair to a biomedical engineering unit or replace the flow meter
Patient is on oxygen and the patient's oxygen saturation is declining	Patient is not getting oxygen flow	• Check that oxygen is flowing from the delivery device • Check that the oxygen tubing is connected to the flow meter • Check that the correct oxygen flow is set

Bubble Humidifier:

There is no specific corrective maintenance for reusable bubble humidifiers.

The following list indicates when the device should be replaced:

- Replace cracked/leaking reservoir or lid seal
- Replace damaged threaded connecter to the flowmeter or concentrator outlet
- Replace the reservoir or lid if there is any sediment or scaling that is not possible to clean out.

Nasal Cannula, catheter, oxygen tubing:

Replacement is required if broken or malfunctioning

Pulse oximeter:

Problem/fault	Possible cause	Solution
Equipment is not running	• No power from mains socket	• Check power switch is on • Replace fuse with correct voltage and current if blown • Check mains power is present at socket using equipment known to be working • Contact electrician for rewiring if power not present
	• Battery (if present) is discharged	• Recharge or replace battery
	• Power supply cable fault	• Try cable on another piece of equipment to determine the power cable or the device is faulty • Contact biomedical engineering unit for repair if required
SpO2 or pulse rate not displayed or unstable	• Probe is not mounted correctly	• Connect probe and cable properly
	• Probe is dirty	• Remove grease, dirt, nail polish, etc. and clean probe
	• Patient movement	• Request patient to remain still • For paediatric patients, try employing distraction/engagement of the apprehensive child or breast feed (if still breast feeding). • For neonates and infants, try locating the sensor on the foot
	• Patient's SpO2 value is too low to be measured	• Re site probe if necessary. Further clinical examination of patient
	• Internal malfunction	• Device may require replacement. Contact biomedical engineering unit.

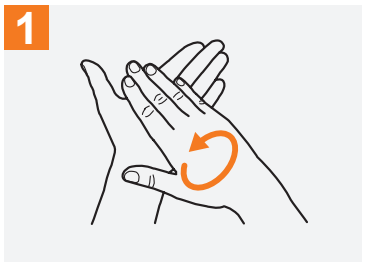
CPAP:

Trouble	Possible cause	Solution
Bubbling absent	Loss of air flow or pressure leak in the system	Differentiate whether system problem or baby problem Remove the prongs from nose and occlude with finger - If bubbling absent > problem in circuit > re-check all connections - If bubbling present > problem in patient > pressure leak via nares or open mouth
Prongs doesn't stay in place	Whether prong size appropriate? Is the hat loose? Are the corrugated tubes are in proper position with prongs	- avoid too small prongs - avoid loose hat - Re position the attachments
Nothing happens when applying power to humidifier	Device may be unplugged	Ensure all cords are properly plugged into the machine and the wall
High leakage	Tubing may not be connected properly and isn't sealing properly	Check mask and tubing for kinks or tears. If there are no tears, try reconnecting tube to the machine
	The machine may not be attached properly to the humidifier	Separate the machine from the humidifier completely and try to reconnect
	The water chamber is not seated properly in the humidifie	Remove the water chamber from the humidifier completely and place back in
Excessive condensation in tubing	Humidity level is too high	Reduce the humidity level setting
	The humidifier is positioned incorrectly	Verify that the CPAP machine and humidifier are positioned away from air conditioning equipment

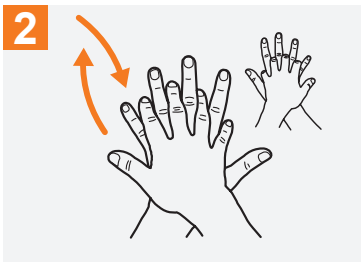
Annexure-VIII

Infection Prevention Measures

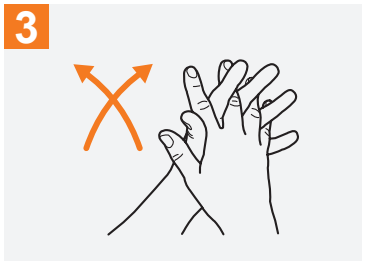
Steps of Hand Wash



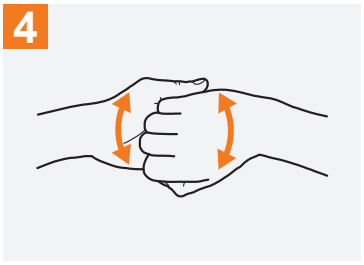
Rub hands palm to palm;



Right palm over left dorsum with interlaced fingers and vice versa;



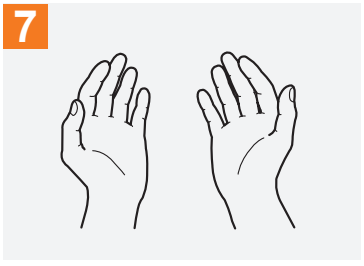
Palm to palm with fingers interlaced;



Backs of fingers to opposing palms with fingers interlocked;

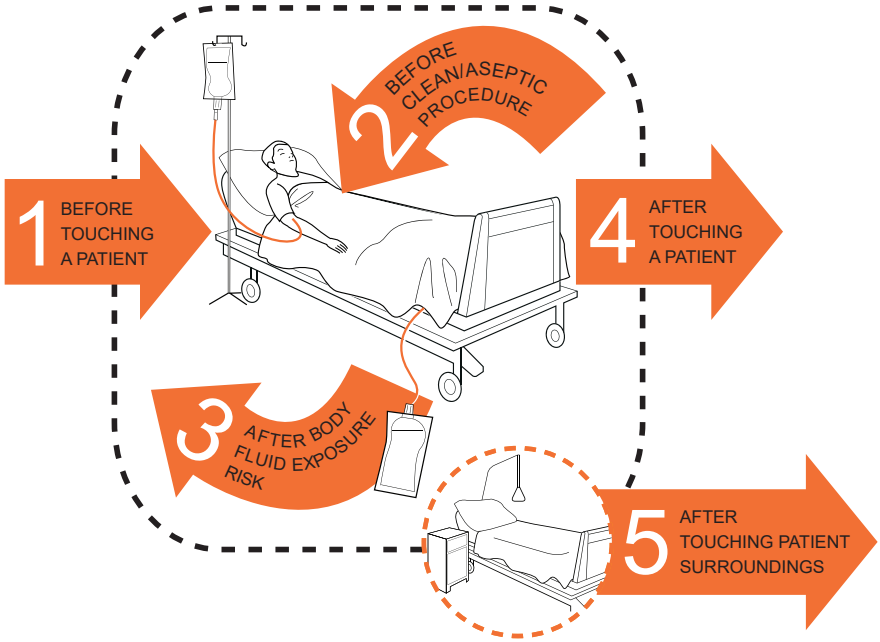
Rotational rubbing of left thumb clasped in right palm and vice versa;

Rotational rubbing, backwar ds and forwar ds with clasped fingers of right hand in left palm and vice versa;



Once dry, your hands ar e safe.

Your 5 Moments for Hand Hygiene



1	**BEFORE TOUCHING A PATIENT**	**WHEN?**	Clean your hands before touching a patient when approaching him/her.
		WHY?	To protect the patient against harmful germs carried on your hands.
2	**BEFORE CLEAN/ ASEPTIC PROCEDURE**	**WHEN?**	Clean your hands immediately before performing a clean/aseptic procedure.
		WHY?	To protect the patient against harmful germs, including the patient's own, from entering his/her body.
3	**AFTER BODY FLUID EXPOSURE RISK**	**WHEN?**	Clean your hands immediately after an exposure risk to body fluids (and after glove removal).
		WHY?	To protect yourself and the health-care environment from harmful patient germs.
4	**AFTER TOUCHING A PATIENT**	**WHEN?**	Clean your hands after touching a patient and her/his immediate surroundings, when leaving the patient's side.
		WHY?	To protect yourself and the health-care environment from harmful patient germs.
5	**AFTER TOUCHING PATIENT SURROUNDINGS**	**WHEN?**	Clean your hands after touching any object or furniture in the patient's immediate surroundings, when leaving – even if the patient has not been touched.
		WHY?	To protect yourself and the health-care environment from harmful patient germs.

World Health Organization | Patient Safety — A World Alliance for Safer Health Care | **SAVE LIVES** Clean **Your** Hands

WHO acknowledges the Hôpitaux Universitaires de Genève (HUG), in particular the members of the Infection Control Programme, for their active participation in developing this material.

May 2009

নবজাতকের রিসাসিটেশন যন্ত্রসমূহের পুনঃপ্রক্রিয়াকরণ

১. প্রস্তুতি

নবজাতক রিসাসিটেশন যন্ত্রসমূহের পুনঃব্যবহারের নির্দেশনা অনুসরণ করুন ঃ

- ব্যক্তিগত সুরক্ষার ব্যবস্থা নিন (গ্লাভস, ক্যাপ, মাস্ক, চোখ সুরক্ষা, অ্যাপ্রন, বুট)
- যন্ত্র পরিষ্কার করার স্থানটি পরিষ্কার করুন
- পুনঃপরিষ্কারের উপাদানসমূহ প্রস্তুত রাখুন
- পরিষ্কারক দ্রবনের পাত্রের গায়ের লেবেলে দ্রবনের নাম, তারিখ ও সময় লিখে রাখুন।

গ্লাভস পরীক্ষা

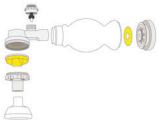
জীবাণুমুক্ত গ্লাভস পরিধান

২. জীবাণুমুক্তকরণের পূর্বে

পরিষ্কারের পূর্বে

যন্ত্রগুলো ৫% ক্লোরিন দ্রবনযুক্ত পরিষ্কার গজ দিয়ে মুছে নিন

যন্ত্রের অংশসমূহ খুলে ফেলাঃ



যন্ত্রের প্রতিটি অংশ খুলে আলাদা করুন

পরিষ্কারকরণঃ

যন্ত্রের প্রতিটি অংশ পরিষ্কার পানি ও সাবান দিয়ে ধুয়ে ফেলুন। কোন ময়লা থাকলে তা ব্রাশের সাহায্যে পরিষ্কার করুন

ধুয়ে ফেলা

প্রতিটি অংশ পরিষ্কার পানি দিয়ে ধুয়ে ফেলুন

দাগ তুলে ফেলুন (যদি প্রয়োজন হয়)

পানি ও ভিনেগার এর সমপরিমাণ দ্রবণে যন্ত্রগুলো ১০ মিনিট ভিজিয়ে রেখে ধুয়ে ফেলুন। প্রয়োজনে এই পদ্ধতি আবার করতে হবে।

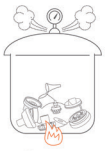
শুষ্ককরণ (স্টেরিলাইজেশন অথবা জীবাণুমুক্তকরণের পূর্বে)ঃ

পরিষ্কার গজ বা কাপড় দিয়ে মুছে শুষ্ক করুন

৩. জীবাণুমুক্তকরণ

যে কোন একটি পদ্ধতিকে বেছে নিন

স্টেরিলাইজেশন অটোক্লেভিং



অটোক্লেভ মেশিন প্রস্তুতকারকের নির্দেশিকা অনুসরণ করতে হবে।

অথবা

উচ্চমাত্রার জীবাণুমুক্তকরণ ফুটানো

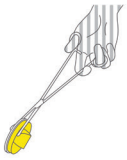
ফুটন্ত পানিতে ২০ মিনিট ফুটিয়ে নিন

অথবা

উচ্চমাত্রার জীবাণুমুক্তকরণ রাসায়নিক

৫% ক্লোরিন সলিউশন এ ২০ মিনিট ভিজিয়ে রাখুন অথবা ২.৪% গ্লুটারালাডিহাইড সলিউশন ব্যবহার; রাসায়নিক প্রস্তুতকারকের নির্দেশনা অনুসরণ করুন
তিনটি ফুটানো স্বাভাবিক তাপমাত্রার পানিভরা পাত্রে পৃথকভাবে ১ মিনিট করে ধুয়ে নিন

তুলে ফেলা



জীবাণুমুক্ত পদ্ধতিতে যন্ত্রাংশগুলো তুলে ফেলুন

শুকানো

অথবা

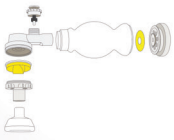
পরিষ্কার জীবাণুমুক্ত গজ দ্বারা মুছে নিন বা বাতাসে শুকিয়ে নিন

৪. জীবাণুমুক্তকরণের পরে

পর্যবেক্ষণ

যন্ত্রের প্রতিটি অংশ অক্ষত পরিষ্কার এবং দাগমুক্ত আছে কিনা দেখুন। যদি পরিষ্কার না হয়ে থাকে তাহলে পুনরায় পরিষ্কার করুন। নষ্ট যন্ত্রাংশ সরিয়ে ফেলুন।

পুনঃসংযোজন

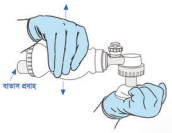


যন্ত্রের খোলা অংশগুলি লাগিয়ে ফেলুন

কার্যকারিতা পরীক্ষা করা

মাস্কটি বায়ুনিরোধক করুন ব্যাগটি জোরে চাপুন এবং লক্ষ্য করুন ভাল্বটি সঠিকভাবে খোলে কিনা

প্রেসার রিলিজ ভাল্ব দিয়ে বাতাস বের হবার শব্দ শুনুন



বায়ুনিরোধক অবস্থায়, প্রতিবার চাপ ছাড়ার পরে ব্যাগটি নিজে নিজে ফোলে কিনা লক্ষ্য করুন

সাকারটি চাপুন, অগ্রভাগটি বন্ধ করুন এবং চাপ ছেড়ে দিন। মুখ না খোলা পর্যন্ত যন্ত্রটি পুনরায় খুলবে না।

সংরক্ষণ

পরিষ্কার করা যন্ত্রগুলি ঢাকনাযুক্ত/ জীবাণুমুক্ত প্লাস্টিক অথবা ধাতব পাত্রে রাখুন অথবা অটোক্লেভ করা কাপড়ে ভালভাবে মুড়িয়ে রাখুন

⚠ * যদি কোন একটি কার্যকারিতা পরীক্ষায় যন্ত্রপাতিগুলো অকার্যকর প্রমাণিত হয় তাহলে যন্ত্রাংশগুলো আবার খুলে লাগান এবং পুনরায় কার্যকারিতা পরীক্ষা করুন। তারপরও যন্ত্রাংশগুলো অকার্যকর প্রমাণিত হলে যন্ত্রাংশগুলো পরিত্যাক্ত করুন।

পুনর্মুদ্রণেঃ ইউএসএআইডি'র 'মামনি' মাতৃ ও নবজাতক স্বাস্থ্যসেবা উন্নয়ন প্রকল্প, ২০১৯

SAFE DISPOSAL OF HOSPITAL WASTE

Proper disposal of hospital waste is important to keep the environment clean. The waste should be disposed off in a proper way. All health professionals should be well conversant with their local hospital policies for waste disposal which may vary from place to place.

The following are different colour drums with different color polythene for different type of waste, to be disposed off in a different way.

a. Black drums / Bags

Left over food, fruits, feeds, vegetables, waste paper, packing material, empty box, bags etc. This waste is disposed off by routine municipal council committee machinery.

b. Yellow drums / Bags

Infected non-plastic waste e.g. human anatomical waste, blood, body fluids, placenta, diapers etc. This type of waste requires incineration.

c. Blue drums / Bags

Infected plastic waste such as used disposable syringes, needles (first destroy the needle in the needle destroyer) and soiled gloves.

Used sharps, blade and broken glass should be discarded in puncture proof containers before discarding.

Patients' IV set, blood transfusion set, end tracheal tube, catheter, urine bag etc. should be cut into pieces and disposed in blue bag. This waste will be autoclaved to make it noninfectious. This is then shredded and disposed off.

* Some hospitals use red drums / bags for disposal of glass, sharps and blades.

Annexure-IX

Monitoring Checklist for babies receiving Oxygen therapy (nasal prongs/ nasal catheter/ hood box/face mask)

(Will be filled up by nurse in each shift/day)

Date:

Monitoring parameters	Morning Time:	Evening Time:	Night Time:
A.Clinical			
Heart rate (/min) Respiratory rate (/min)			
Chest retraction			
Silverman-Anderson score			
CRT			
SPO2			
B.Oxygen delivery device			
Cylinder			
Concentrator			
Flow rate (/min)			
Oxygen tubes patent			
C. Humidification			
Present/ absent			
Temp in humidifier			
D. Interface			
Nasal prongs/nasal catheter/ hood box/face mask			
Size appropriate or not			
Skin near interface (intact/ redness/ excoriation)			
E. Head & neck position			
Days on oxygen			
Assessment: (stable/ respiratory distress increased)			
Filled up by nurse (name)			

Annexure-X

Monitoring Checklist for babies while getting CPAP

(Will be filled up by nurse in each shift/day)

Date:

Monitoring parameter	Morning Time:	Evening Time:	Night Time:
A.Clinical:			
Heart rate (/min)			
Respiratory rate (/min)			
CRT			
Chest retraction			
Silverman-Anderson score			
Abdominal girth (cm)			
B.Equipment:			
PEEP (cm H20)			
Flow rate (L/min)			
FiO2 (%)			
Humidification (present or absent)			
Temp of humidifier			
Water in bubble chamber up to the level (present or absent)			
Bubbling is present in water chamber			
Corrugated tubing are correctly placed			
C.Interface:			
Prongs/ mask			
If prongs –touching collumella or not			
Nasal septum area (any redness/ skin excoriation/ swelling/ damaged)			
Chin strap if used (tight/loose)			
D. Position of baby's head and neck			
Days in CPAP			
Assessment: (stable/ respiratory distress increased)			
Filled up by nurse (name)			

Annexure-XI

Patient Individual Case sheet

Patient information		Treatment
Name		
Patient ID/registration #		
Sex		
Age		
Wt		
Date:		
Dx.		
Physical examination		
Medical follow up (last date)		
Child Consciousness (Active/lethargy/Unconscious)		
Pulse		
BP		
Temp		
SpO2		
Respiratory Rate		
Severe Chest indrawing (Y/N)		
Central cyanosis (Y/N)		
Lung examination		
Head nodding (Y/N)		
Any injury/inflammation at the oxygen interface site (Y/N)		
Investigation		
TC, DC, HB%, ESR		
Blood Film		
Urine RE		
Stool RE		
RBS/FBS		
CXR		
USG		
Other-		

Annexure-XII

Daily Monitoring Chart

Guidance: Should be filled up 6 hourly for preterm babies Monitor frequency will depend patient condition (if required)																
Date:																
1. Patient information																
Patient ID:																
Child name:																
Gender:																
Age:																
Weight:																
Diagnonsis:																
	Day 1				Day 2				Day 3				Day 4			
2. Vital sign																
Consciousness level																
Pulse rate																
Temperature																
SpO2																
Respiratory rate																
Severe Chest indrawing (Y/N)																
Central cyanosis (Y/N)																
Lung examination																
Head nodding (Y/N)																
Any injury/inflammition at the oxygen interface site (Y/N)																
3. Fluid balance (record volume and times)																
IV																
By nasogastric tube																
oral																
Fluid output																
4. Treatment given																
Name of treatment																
Oxygen Flow Rate (LPM)																
5. Feeding/nutrition																
Child breastfed																
Drink taken																
Food taken																
Feeding problems (given details)																
Weight																
6.Outcome																

Annexure-XIII

Daily Monitoring Checklist for Hypoxaemia Cases on Oxygen therapy

*(Will be filled up by doctor/nurse/others in each shift for **all Hypoxaemia cases** admitted in the unit)*

Name:
Patient ID:
Bed no.
Date:
Time:
Diagnosis: ..... With Hypoxaemia

Monitoring parameters	**Morning Shift** **Name of Doc/SSN:** **Time:**	**Evening Shift** **Name of Doc/SSN:** **Time:**	**Night Shift** **Name of Doc/SSN:** **Time:**
Patient individual case sheet is available (Yes/No)	**Y / N**	**Y / N**	**Y / N**
Patient individual case sheet is properly filled (Yes/No)	**Y / N**	**Y / N**	**Y / N**
Patient Monitoring Chart is available and properly recirded (Yes/No)	**Y / N**	**Y / N**	**Y / N**
SpO2 and oxygen flow rate is properly filled in monitoring chart (Yes/No)	**Y / N**	**Y / N**	**Y / N**
SPO2 **(add exact value)**			
Oxygen therapy is given according to guideline (Yes/No)	**Y / N**	**Y / N**	**Y / N**
Flow rate (Litre/min) **(add exact value)**			
O2 Flow Rate is as per advice in the case sheet	**Y / N**	**Y / N**	**Y / N**
Oxygen delivery device* and interfaces are functional (Yes/No)	**Y / N**	**Y / N**	**Y / N**
Data entry in register and reporting for hypoxaemia are properly done	**Y / N**	**Y / N**	**Y / N**

***Oxygen Delivery devices: Device (e.g cylinder/Concentrator/Central outlet)**
Interfaces (e.g nasal prongs/ cannula/Masks)